ORDNANCE

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Published in two sections

DWIGHT D. EISENHOWER
Commander in Chief
United States Armed Forces

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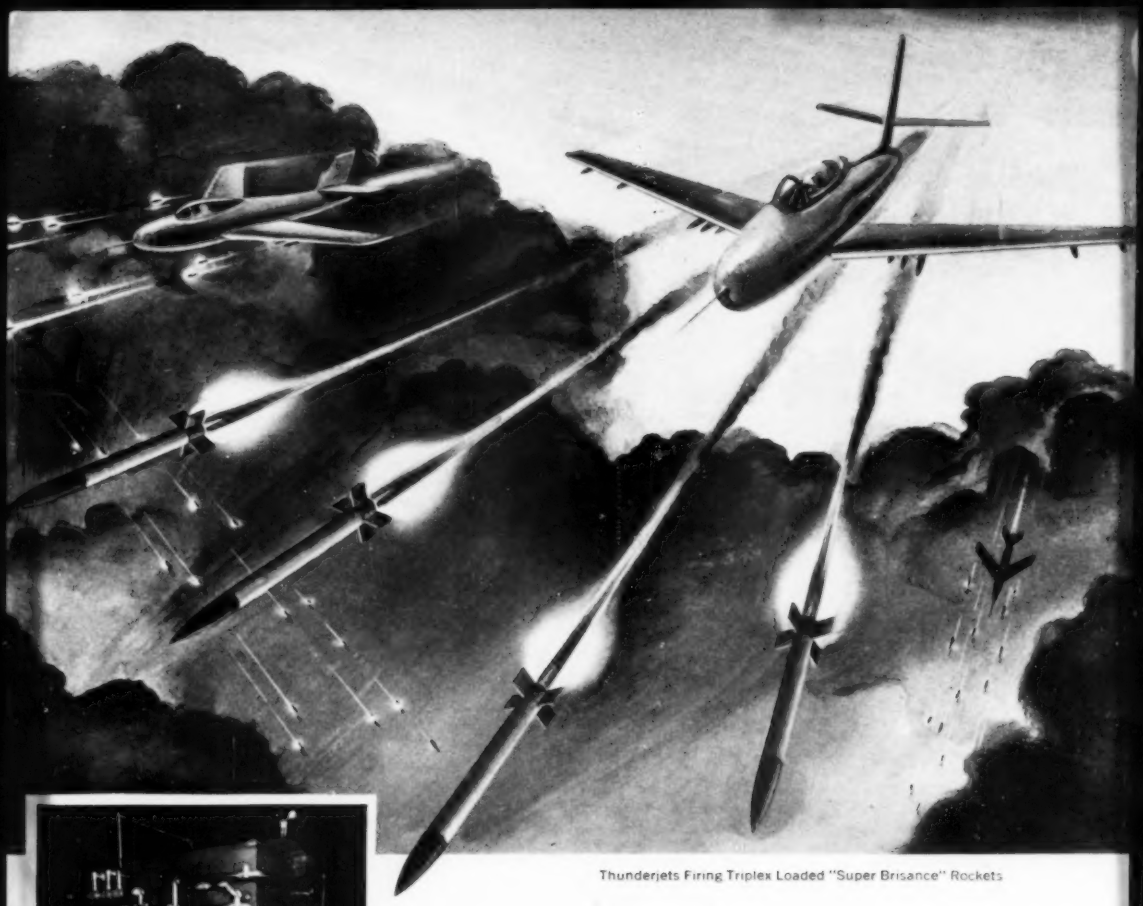
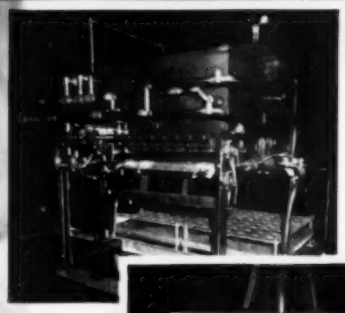


Thunderjets Firing Triplex Loaded "Super Brisance" Rockets



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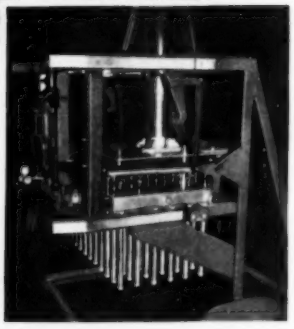

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The Magazine of Scientific and Industrial Preparedness

Vol. XXXVII JANUARY-FEBRUARY, 1953 No. 196

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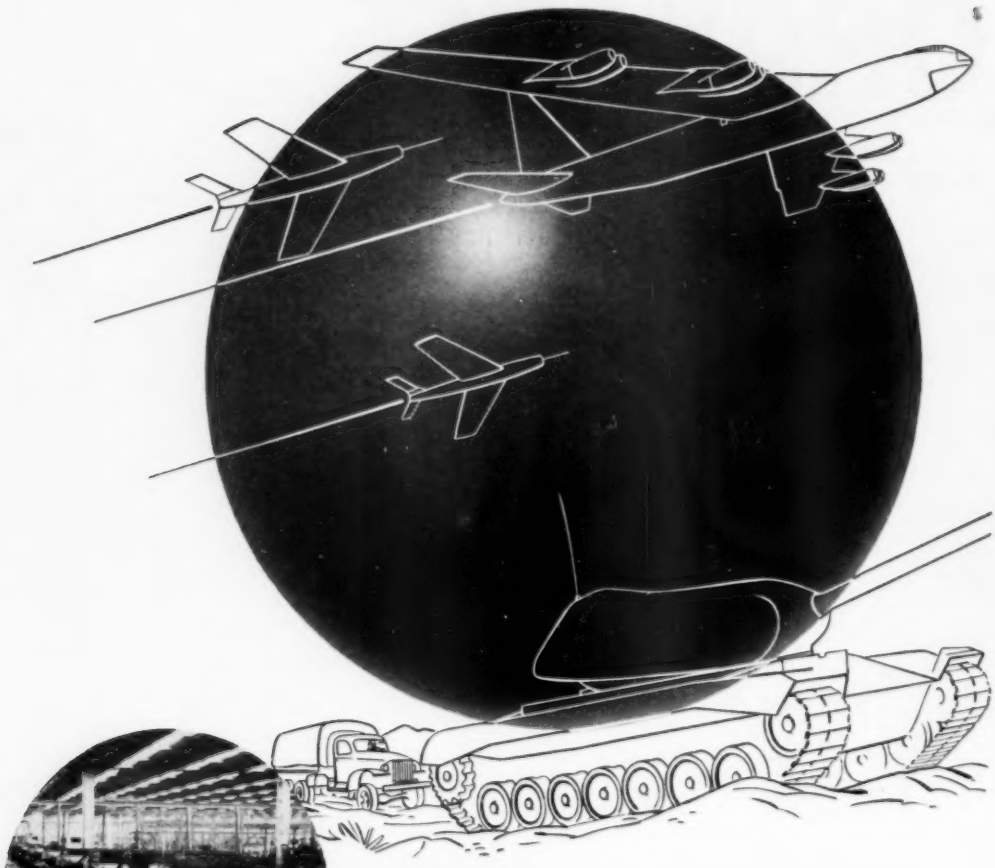

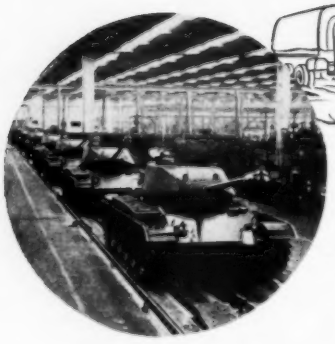

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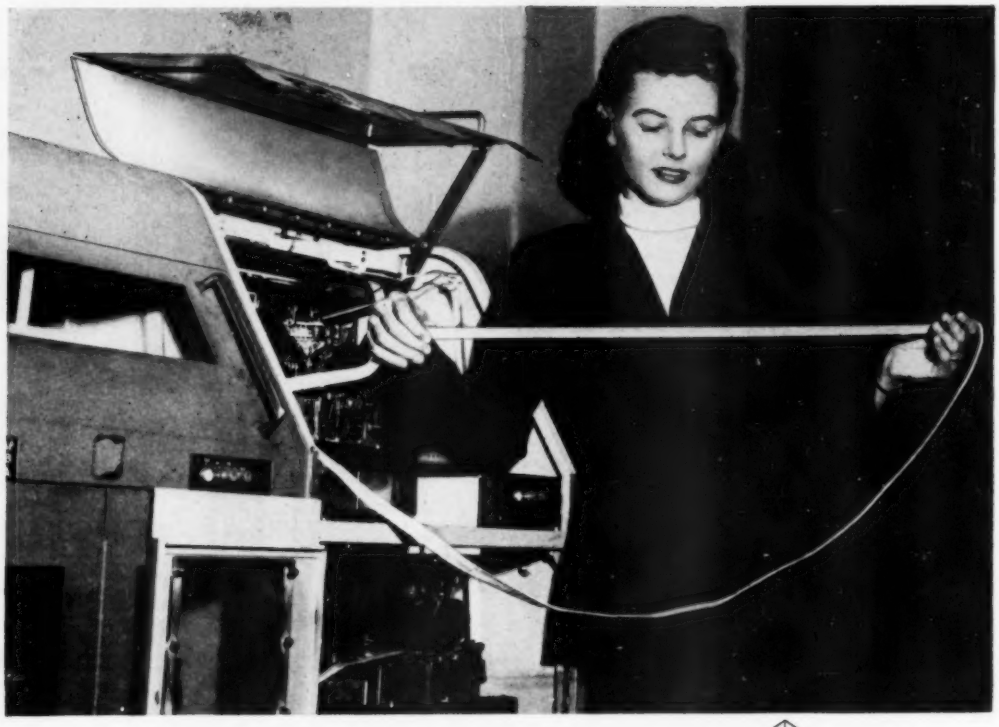
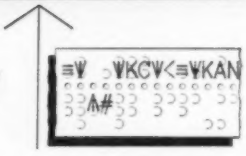


These signals find the way



SENDING

RECEIVING

When you dial a telephone number, high-speed switching mechanisms select your party and connect you. Through a new development of Bell Telephone Laboratories, similar mechanisms are doing the same kind of job in private wire teletypewriter systems which America's great businesses lease from the telephone company.

Company X, for example, operates an air transportation business with scores of offices all over the country. At one of these offices, a teletypewriter operator wishes to send a message, let us say, to Kansas City. Ahead of the message, she types the code letters "KC". The letters become electric signals which guide the message to its destination.

Any or all stations in a network, or any combination of stations, can be selected. Switching centers may handle 50 or more messages a minute . . . some users send 30,000 messages a day. Delivery time is a few minutes.

Defense manufacturers, automobile makers, airlines and many other American businesses are benefiting by the speed and accuracy of the new equipment – another example of how techniques developed by the Laboratories for telephone use contribute to other Bell System services as well.

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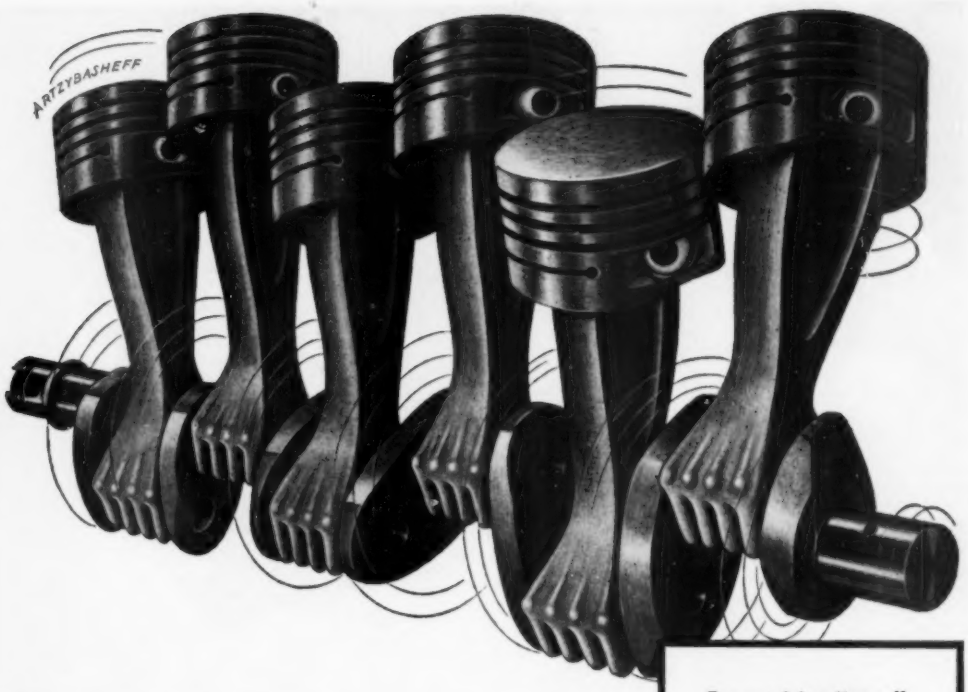
Improving telephone service for America provides careers for creative men in scientific and technical fields.



Six strong arms and "true"

Six powerful arms of steel grip and turn the crankshaft—send power from pulsing pistons surging through the mighty Ford truck. These connecting rods are machined to tolerances of 3/10,000 of an inch—diamond-bored for precision—dynamically balanced to 1/10th of an ounce for peak performance. That's precision production—and for such exacting work in great volume, Ford Motor Company depends on Lycoming.

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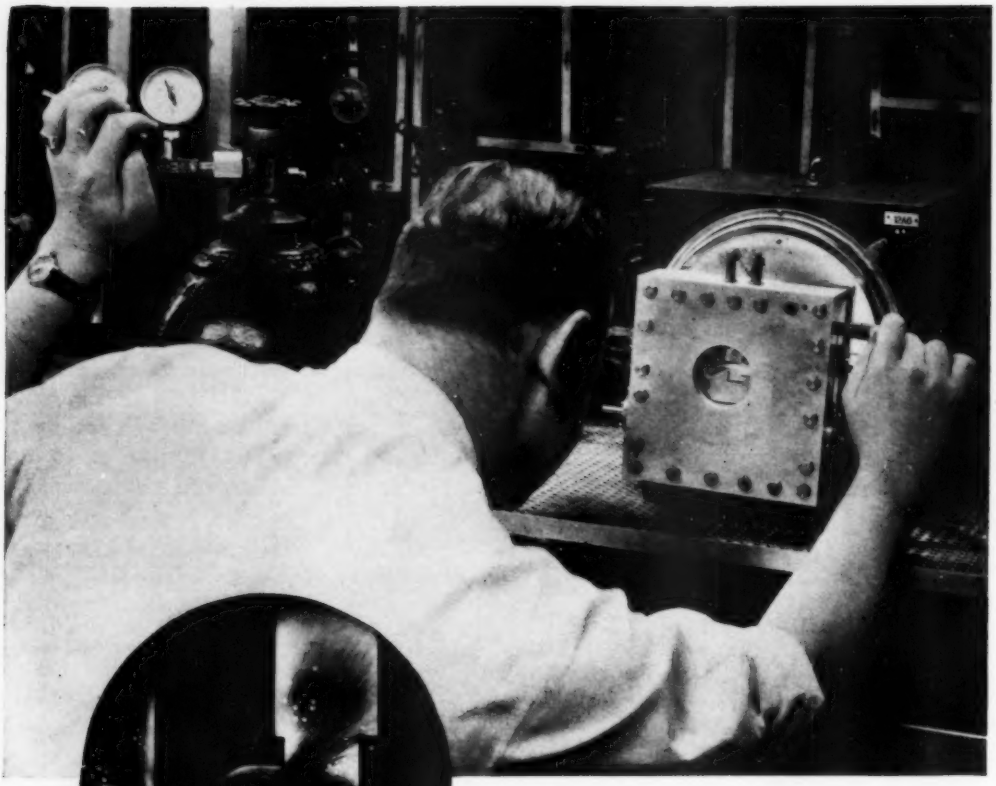

Fundamental Research for Tomorrow's Aircraft

This Sperry engineer is applying the fundamentals of hydraulics to determine oil flow characteristics at high pressure. Here he introduces nitrogen to the hydraulic fluid in a complex valve to make flow patterns visible for study.

This is an example of the fundamental engineering which precedes the design of high-power booster servos for use in automatic as well as manual flight.

Automatic controls for tomorrow's aircraft require extensive fundamental research. Not only in hydraulics, but in aerodynamics, electronics and gyros, Sperry engineers are establishing new sets of rules to work under.

For 40 years Sperry has been working continually on flight control problems. Currently, Gyropilot* flight controls are flying jet, propeller-driven, rotary-wing, lighter-than-air and pilotless aircraft.

With this background of leadership and experience and the constant exploration of fundamentals for new concepts of design, Sperry is able to anticipate and solve control problems for tomorrow's aircraft.

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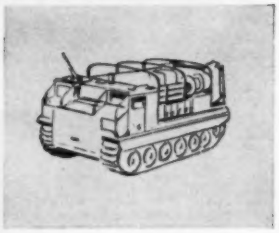

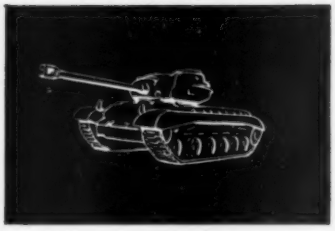

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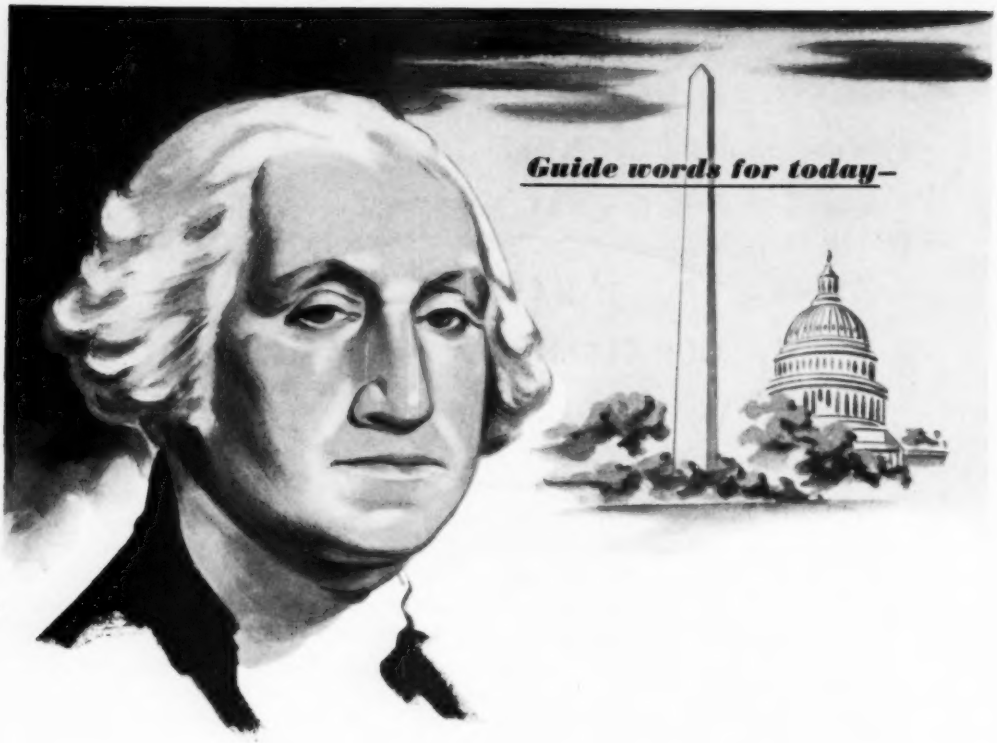

"Our country's honor calls upon us for a vigorous and manly exertion; and if we now shamefully fail, we shall become infamous to the whole world."

—GEORGE WASHINGTON

The selection of a new President is a time for new hope and renewed determination. The President-elect carries with him the high hopes of Americans for a new era of peace and prosperity under great leadership.

The problems are difficult, the decisions grave, the crises urgent. "Blood, sweat, toil and tears" are as necessary now in the cause of peace as they were in the cause of war. But with faith, freedom and "manly exertion" on the part of all citizens, the nation can again move forward to her great destiny, and help achieve the lasting peace to which all the world's people aspire.

W B Stuart

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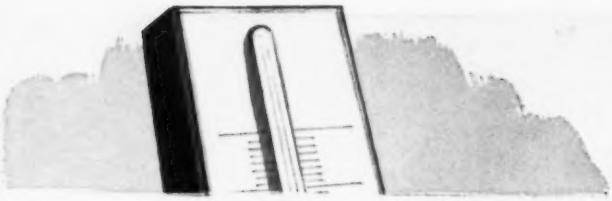
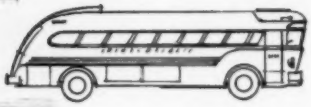
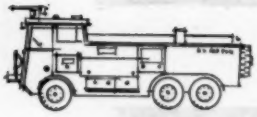
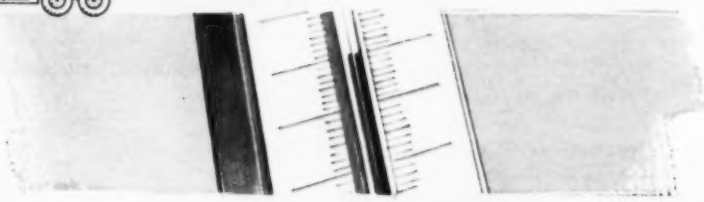


ALL-WEATHER

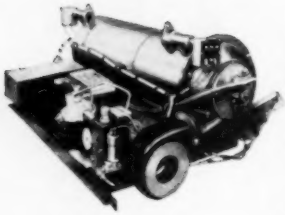




OPERATION ASSURED



with JANITROL LIQUID HEATERS



It's a cold hard fact that *reliable operation in any weather*—right down to 65° below zero—is a tough spec for any vehicle. But it's a requirement that can be met in full with Janitrol liquid heaters—as severe tests have proved repeatedly. On the USAF bomber tow tug built by Euclid Road Machinery Company, for example, positive starting was accomplished without special fuel capsules at –65°F after a 72-hour cold soak, and engine temperature jumped to the 155° to 165°F range well within 60 minutes.

If you're responsible for protecting investments in any vehicles or stationary engines or mobile power plants, gasoline or diesel powered, you'll do well to look into the 6-year long record of Janitrol liquid heater reliability. Your nearest Janitrol representative is always at your service.

HEAT WHEREVER YOU WANT IT

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On the double

...WHEN THE GOING IS ROUGH

About a million and a half yards of tough, loamy material had to be moved when Cecil Field's two new jet plane runways went in. Each of the double runways at the Florida field is 9,400 feet; average haul distances ran from 4½ to 5 thousand feet. To move all that soil and sand that distance in a hurry, Contractors L. G. Defelice & Son of New Haven, Conn., turned loose ten "Caterpillar" DW20 Tractors with ten W20 Wagons. Also on job were D8 Tractors, No. 80 Scrapers, No. 12 Motor Graders.

The DW20 Tractor is all-"Caterpillar" built, with power and capacity precisely balanced. It delivers a steady 225 HP at the flywheel and has good lugging qualities. Three-point suspension gives smoother oscillation and roadability, does away with frame twisting, prevents overloading of any one tire, wheel or spindle. Pulling a loaded wagon, the DW20 can hit 26.6 m.p.h.

The W20 Wagon hauls 25 heaped yards or 17 struck. A hydraulic ram regulates its doors from the driver's seat and dumping can be accurately controlled. And its huge, open-top hopper is an easy target for shovel operators.

Fred Sebastian, Project Manager at Cecil Field, summed up this big yellow team: "They can't be beat for power, speed and efficiency. They've far exceeded our expectations."

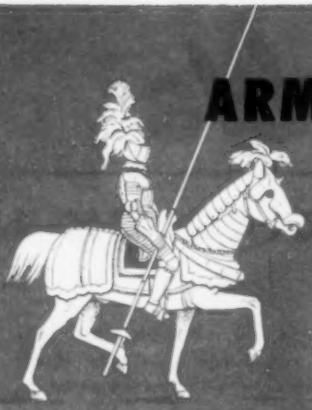
CATERPILLAR, PEORIA, ILLINOIS

CATERPILLAR

REG. U. S. PAT. OFF.

DIESEL ENGINES
TRACTORS • MOTOR GRADERS
EARTHMOVING EQUIPMENT

ARMORED MITE . . . versus . . . .



The mediaeval knight, his armor polished and shining, must have made a colorful sight as he charged through the castle gate to meet the foe in head-on battle. His plate armor was ingeniously designed to protect him from sword and spear, battle axe and hammer. The Knight whose armor provided the *best protection* and offered the *greatest mobility* usually returned the victor. History tells us that metal craftsman of the Middle Ages* vied with one another to develop better protection for their warriors. Then as today, applied talents in the design and metallurgy of armor plate proved the decisive factor in combat.

Here at Standard Steel Spring Company we have mobilized a great group of fully staffed and equipped plants to make essential armor plate for tanks. We engineer the parts, tool for their most economical production, work with our subcontractors in closest contact with procurement, production and inspection.

Now from these centrally coordinated facilities a steady flow of flat or formed, fully machined tank components is reaching all major producers. If you have a need for armor plate or are interested in a redesign program for greater economy or speedier production, your inquiries are invited.

*ARMOR AS IT WAS

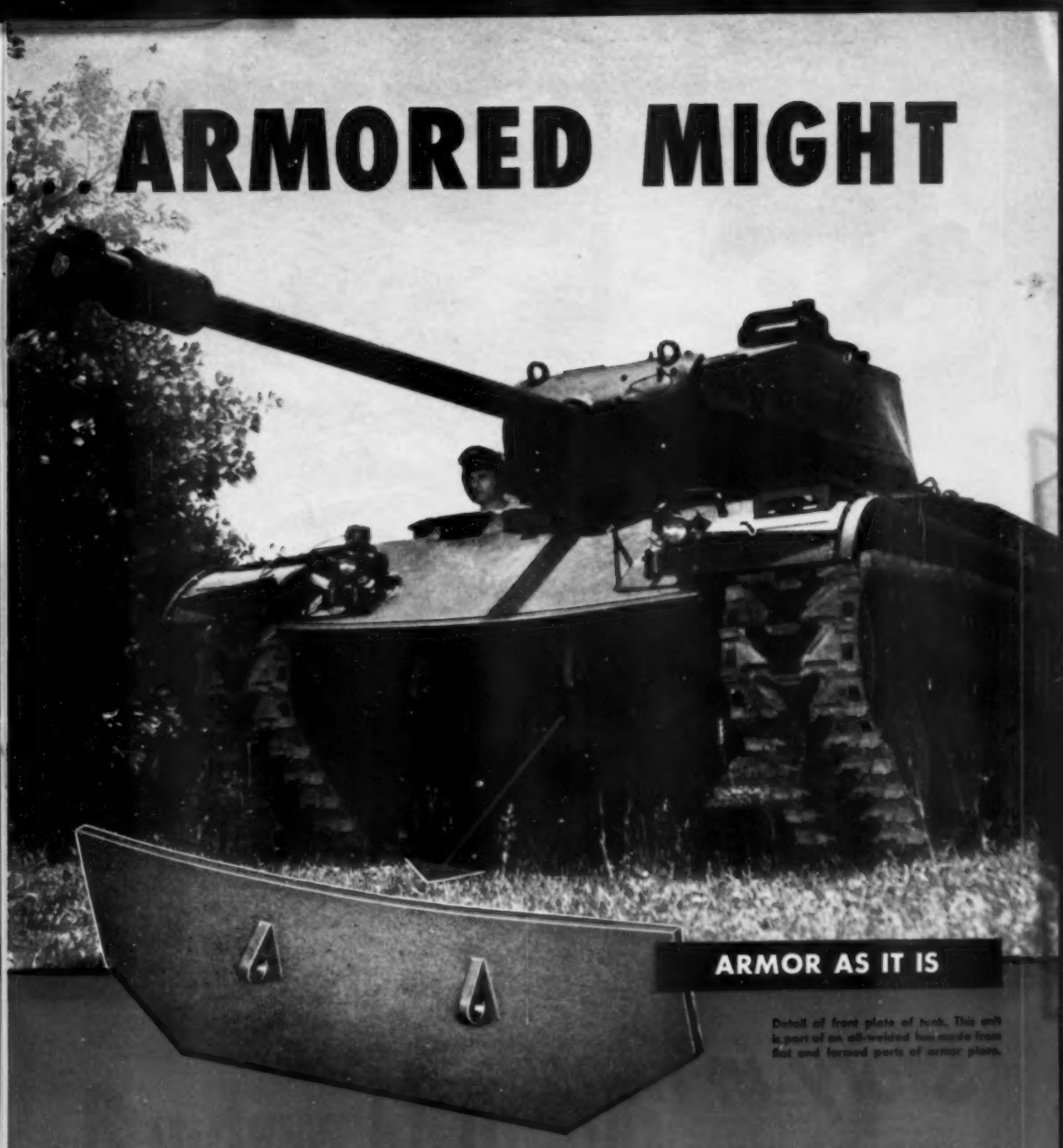
One historian describes the Middle Ages as the period between the civilization of the ancients and that of the printing press. Then "Knighthood was in Flower" throughout England and the Continent. The suit of armor illustrated was worn in the 16th century; made probably in Milan or Brescia. Note the ingenious construction involving overlapping plates that provided full protection while permitting the knight to bend his arms and legs in battle.

Standard Steel Spring Company

ARMOR PLATE DIVISION • PENOBSCOT BLDG. • DETROIT, MICHIGAN

ARMOR PLATE

. . . ARMORED MIGHT



ARMOR AS IT IS

Detail of front plate of tank. This unit is part of an all-welded hull made from flat and formed parts of armor plate.

EVERY FACILITY FOR PRODUCING ARMOR PLATE

Ready to Assemble in Gauges from ¼" to 4" Inclusive

—for Ordnance

Story in two parts

The story of American business is now divided into two important parts: production for industrial requirements and production for defense.

The activities of American Locomotive are typical of the way many companies are meeting these dual needs of today's semi-military economy.

From one group of Alco production lines, for example, come Diesel-electric locomotives for railroads . . . process equipment for refineries, chemical plants and power plants . . . stationary Diesel engines for pipeline pumping stations and power plants.

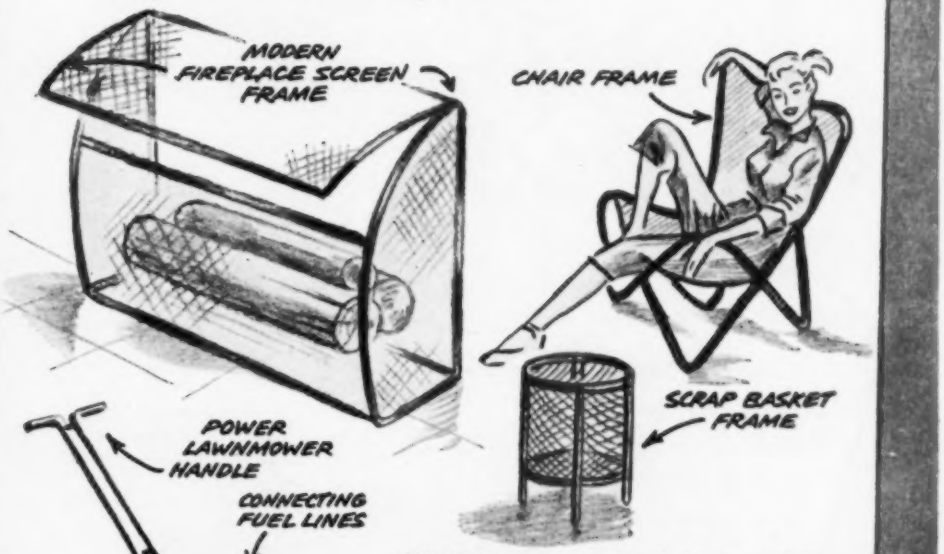
And from other facilities roll the army's medium tanks . . . jet engine containers for the Air Force . . . nickel-plated pipe for the Atomic Energy Commission.

It is this side-by-side production for both defense and industry that helps make America secure.

AMERICAN LOCOMOTIVE COMPANY

producing both industrial and defense products

FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*



REMARKS Need better tubing performance? Want easier, lower-cost fabrication? In Bundyweld, you buy the industry's most versatile, dependable tubing -- backed by engineering skills dedicated to helping Bundy customers save time, materials, money.

WRITE us for catalog or for help on your tubing idea or tubing problem.
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Bundyweld Tubing

® DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile

Lightweight
Machines easily
Takes plastic coating
Scale-free
Bright and clean
No inside bead
Uniform I.D., O.D.

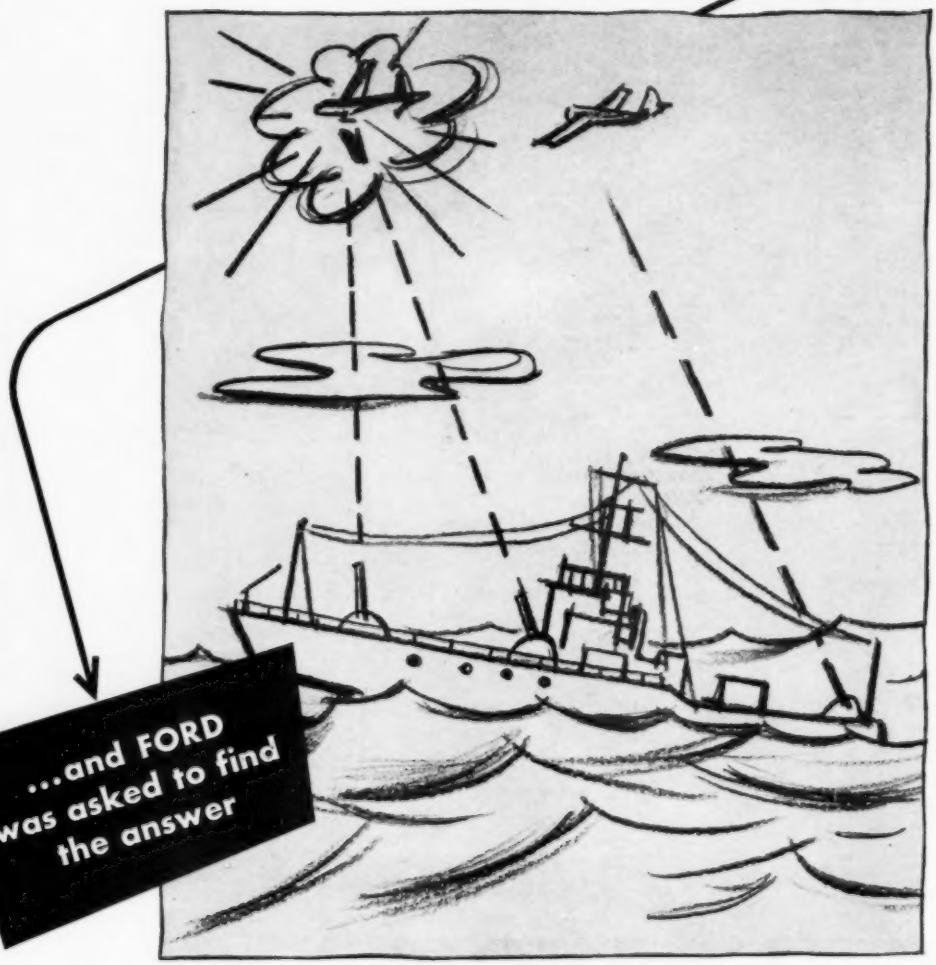
WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Result . . . Bundyweld, double-walled and brazed through 360° of wall contact.

← NOTE the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: Cambridge, 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • **Chattanooga 2, Tenn.:** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • **Chicago 32, Ill.:** Lapham Hickey Co., 3333 W. 47th Place • **Elizabeth, New Jersey:** A. B. Murray Co., Inc., Post Office Box 476 • **Philadelphia 3, Penn.:** Rutan & Co., 1717 Sansom St. • **San Francisco 10, Calif.:** Pacific Metals Co., Ltd., 3100 19th St. • **Seattle 4, Wash.:** Eagle Metals Co., 4755 First Ave., South **Toronto 5, Ontario, Canada:** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

TO HIT TARGET
from unstable decks of ship



A rolling, pitching ship... under attack from speedy, diving aircraft... counts on its anti-aircraft guns for protection... these guns must be able to stay on the target regardless of sea conditions. That's why the Ford Instrument Company was called on to design and build a control system that tracks and holds the target range with deadly accuracy.

This is typical of the problems that Ford has solved since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic, electro-mechanical, magnetic and electronic instruments that bring us our "tomorrows" today. Control problems of both Industry and the Military are Ford specialties.

You can see why a job with Ford Instrument offers young engineers a challenge. If you can qualify, there may be a spot for you in automatic control development at Ford. Write for illustrated brochure.

FORD

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DIVISION OF THE SPERRY CORPORATION
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RED RING
INTERNAL-EXTERNAL
GEAR SHAVING
MACHINES
For the Precision
Finishing of Gears
Up To 120" PD
Other models available for gears
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SPUR AND HELICAL
GEAR SPECIALISTS
ORIGINATORS OF ROTARY SHAVING
AND ELLIPTOID TOOTH FORM
NATIONAL BROACH & MACHINE CO.
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TODAY

—complete output of the SONOTONE-designed Sintered-Plate Nickel Cadmium storage battery is consigned to the United States Government exclusively.

TOMORROW

— this great new battery — developed and now being produced by SONOTONE—will be made available to American industry for civilian use. Inquiries regarding its availability for defense contracts and eventual commercial use are invited.

the battery the world is waiting to use

BATTERY DIVISION

SONOTONE CORPORATION

Elmsford, New York

Remington Rand Methods News

Let's talk control methods at Cleveland Maintenance Show

Many types of effective records for maintenance control can be studied at Booths 507 and 511, Public Auditorium, Jan. 19-22

For profitable new approaches to the record-keeping problems of a maintenance department, there's nothing like seeing how other firms get results. Also, at the Maintenance Show, we will introduce to you a new idea or two in maintenance control — demonstrated for the first time anywhere.

And, naturally, we will show you many of the production and materials control methods described in our manual X-1268. If you can't visit with us in Cleveland, be sure to send coupon below for helpful literature on subjects of interest to you.

Look to your preventive maintenance record for help in keeping plant output at peak

As production equipment grows more complicated, a breakdown becomes more costly. Preventive maintenance control is more vital than ever for plant efficiency. Your records must help *prevent* the failures – or else!

Maintenance superintendents who have a healthy hatred for paperwork always like our simplified visible methods which give maintenance *control* with minimum clerical work.

These methods visually signal the next inspection date for *every* piece of equipment; tell what inspection is needed; permit scheduling of work ahead. Every man's time can be planned for maximum efficiency. Maintenance work loads can be stabilized.

Also, these methods eliminate the guesswork on proper interval between inspections. Decisions can be made on the basis of actual experience for each type of equipment.

Likewise, the records help fix responsibility for an unnecessary breakdown; revealing whether the failure was due to operator abuse or careless maintenance work.

The plant engineer gets all the facts for determining when it will pay to replace a part or machine. He has a complete and convenient history of servicing and repair costs, as well as depreciation on the equipment.

These methods are flexible; can be adapted to your own special needs. See how they have been tied in with preventive maintenance manuals; adapted to special types of equipment such as electric motors; etc.

Study the procedures and methods, as well as preventive maintenance and property records used successfully in many well-known plants. Ask for folders **KD-656** and **KD-705,** also for methods file **MC-727** which is available on a ten-day loan.

Get better maintenance from smaller inventory

There's a firm of 2,000 employees operating on a total maintenance inventory of only $30,000 *which turns over at the rate of nine times a year.* What's more, they don't have to worry about running short of any part or material needed to keep the machines running.

This achievement was made possible by centralizing the inventory records and the purchasing of maintenance supplies under a control system which Remington Rand designed and installed.

Previously, individual department heads had done much of their own buying. This led to wasteful duplication of stocks. Likewise, they passed up the valuable savings of volume buying because each plant bought from its own sources. Nor could they get the service which comes with planned buying.

Previously, an entire department might be shut down for lack of a single part in the stockroom when it was needed. Now the stocks cannot fall below a safe minimum on any item without management knowing about it.

Let us show you how such a system can work for small plants or large – with minimum paperwork. Ask for our new methods file **MC-802.**

QUICK RELIEF FOR COMMON MAINTENANCE HEADACHES

A small part can give you a big pain – when it's the wrong part. Poor description of parts and materials brings all kinds of trouble: shortages and repair delays, duplications and overstocks. But the cure is simple. Identify and classify each item properly, so it can be referred to by exact number at every step from purchasing to costing. See how our engineers have helped other firms accomplish this at minimum cost. Ask for booklet **BSD-10.**

Remington Rand

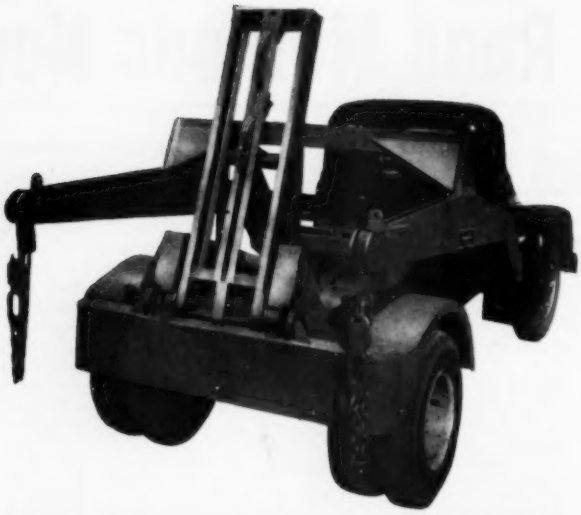
Management Controls Reference Library
Room 1636, 315 Fourth Avenue, New York 10

Please circle the literature you desire:

X-1268	**KD-656**	**KD-705**
MC-727	**MC-802**	**BSD-10**

Name_____
Title_____
Firm_____
Address_____
City_____

P-8



WHY USE 3 TO 5 TRUCKS... WHEN ONLY ONE WILL DO?

In many plants a Dempster-Dumpster, like the one above, operated by only one man, the driver, has replaced 3 to 5 conventional trucks and crews. The reason for this is that one truck-mounted Dempster-Dumpster serves scores of Dempster-Dumpster Detachable Containers up to four times the capacity of the average dump truck body. These containers are built in a wide variety of designs best suited to the type of materials handled—be they bulky, light or heavy . . . solids or liquids . . . trash or rubbish. Containers are conveniently located at accumulation points inside and outside buildings. To illustrate the flexibility of the Dempster-Dumpster System in handling all types of materials in your plant, we show, at right, a few of the dozens of Dempster-Dumpster Containers built to meet every bulk materials handling need. And remember, one truck-mounted Dempster-Dumpster handles all containers, regardless of capacity or design.

The Dempster-Dumpster System eliminates standing idle time of crews and trucks . . . eliminates re-handling of materials . . . increases efficiency, sanitation and good housekeeping . . . cuts cost of truck equipment and operation tremendously. Without question, it's the most efficient and lowest cost method of bulk materials handling by truck ever devised! The chances are this system will save you thousands of dollars annually. This equipment manufactured and sold exclusively by Dempster Brothers, Inc.

WHEN A CONTAINER IS FULL, the Dempster-Dumpster picks it up, hauls to destination and dumps the materials or sets load down intact. These three simple operations, shown above, are hydraulically controlled by driver in truck cab.

Drop Bottom Container built up to 10 cu. yd. capacity to handle heavy materials.

Tank Type Container meeting A.S.M.E. specifications. Capacities up to 1,200 gallons.

Tilt Type with Converged Lip for handling fine aggregate, wet or fluid materials.

Drop Bottom Pressed Steel Type for lighter service.

Universal Type built up to 12 cu. yd. capacity with top and end doors.

Five cu. yd. container with swivel casters for handling waste blast sand.

DEMPSTER BROTHERS, 913 Shea Bldg., Knoxville 17, Tennessee

when you buy presses...

take a close look at

LUBRICATION

DANLY gives you a completely automatic oil lubrication system—built in "preventive maintenance"—that assures an ample supply of lubricant to all wear points at all times. It saves hundreds of hours of routine maintenance, press down time is greatly reduced—and your presses are positively protected against damage due to lubrication failure or neglect!

DANLY MACHINE SPECIALTIES, INC.

2100 South Laramie Avenue, Chicago 50, Illinois

AUTOMATIC GUARDIAN OF PRESS LUBRICATION . . . This Danly-engineered switch monitors the flow of oil to the vital driveshaft bearings. Should oil flow stop in any line, this switch also stops the press immediately before serious damage occurs and also indicates the faulty line.

DANLY

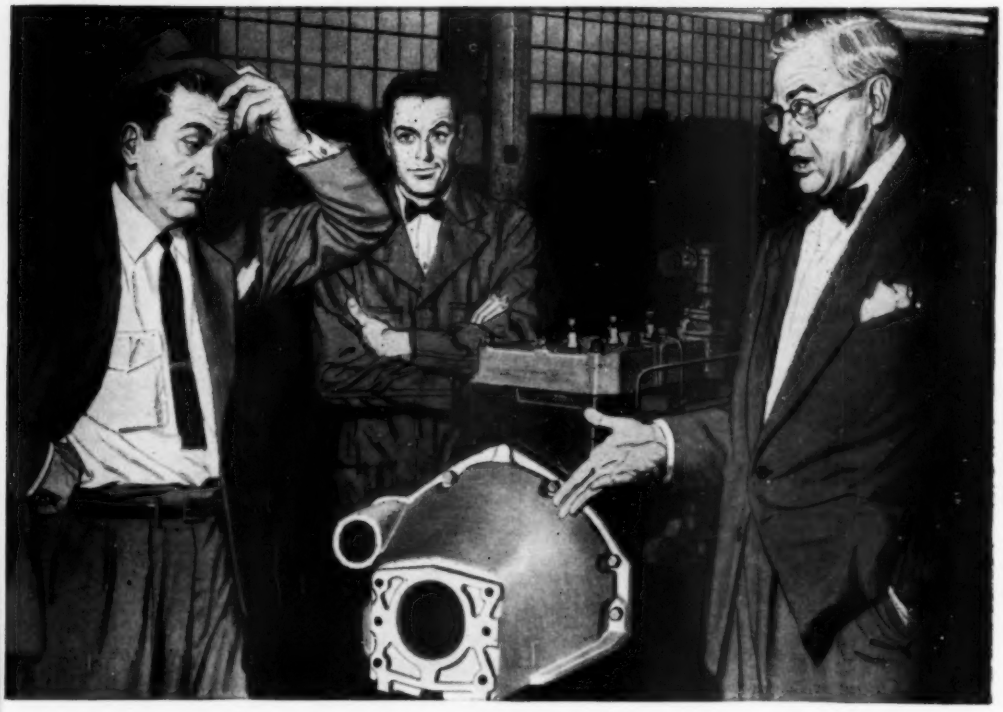
MECHANICAL PRESSES . . . 50 TO 3000 TONS

HYDRAULIC METALWORKING EQUIPMENT

CONTINUOUS AUTOMATIC OIL LUBRICATION INCLUDES GIBS . . . Cutaway view of typical Danly Press shows how vital wearing surfaces are protected by the Danly complete automatic oil lubrication (in color) system. Oil gib lubrication permits extra close slide adjustment, longer die life.

It costs less to run a DANLY PRESS!

Single Action Straight Side | Autofeed | Underdrive Single, Double, Triple Action | Gap Frame | Double Action Straight Side



Why can't this be an ALUMINUM DIE CASTING?

This challenge was thrown at us by a leading automobile maker.

"It's possible," we agreed. But . . . the clutch housing also supports half the engine's weight, it is highly stressed, must absorb vibration. Could a die casting economically be made that strong?

An Alcoa Development Program was started. With the auto maker we drew up designs. We selected our strongest die casting alloy; poured *sand castings* from it; machined it to the dimensions of the die casting design.

Shear static loads and bending stresses were measured. Brittle lacquer and strain gages show us stress concentrations. Castings, engine and transmission were assembled, then run with an unbalanced shaft to measure dynamic stresses.

With the auto maker we modified designs. Die castings were made. We repeated the laboratory tests while the auto maker made road tests. The first stressed automotive die casting was a success. 25% stronger in shear, 10% stronger in bending, 100% better in fatigue life than the original clutch housing. Only ¼ as much weight as the original cast-iron housing. *And 15% lower in cost.*

This case is typical of the engineering problems Alcoa men undertake and solve. The same research, test and development facilities stand ready to help you make the best possible use of aluminum for defense needs.

COMPANY OF AMERICA
850-A Gulf Building • Pittsburgh 19, Pennsylvania

A business built on co-operation

ALCOA®

ALCOA

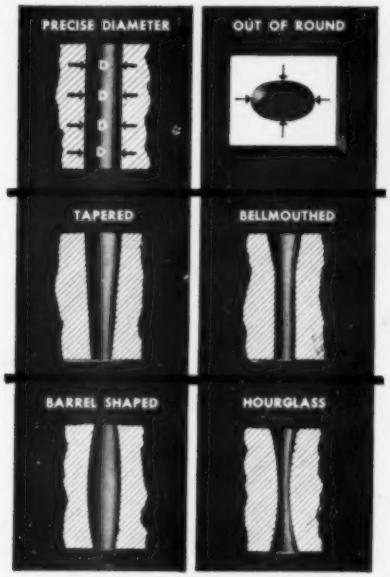
ALUMINUM COMPANY OF AMERICA

Precisionaire Spindles

SHOW YOU WHAT PLUG GAGES CAN'T

—and wear 10 to more than 100 times longer!

A PRECISIONAIRE STANDARD SPINDLE SHOWS WHETHER A HOLE IS:



A Precisionaire and *standard* spindle shows you instantly whether a hole is dimensionally O.K.—and, if not, *what* the error is, *where* it is, and *how* much.

Precisionaire spindles prevent accepting bad parts in Receiving Inspection. In Production Inspection they show when and how to adjust a machine *before* scrap is produced. They prevent passing incorrect parts in Final Inspection.

Other Precisionaire spindles and fixtures for single and multiple gaging of internal and external diameters, squareness, concentricity, center distance, etc., are readily available.

A PLUG GAGE SHOWS YOU ONLY

Whether the hole being checked will assemble with a mating shaft of known diameter—it cannot measure any condition shown at the left.

Stock Delivery on Precisionaires—4 weeks delivery on Standard Spindles and Master Settings Rings Sizes .125 to 4.000". See your Sheffield Representative or write for new Precisionaire Catalog.

4947

MASTER CRAFTSMEN SHEFFIELD HEADQUARTERS

the *Sheffield* CORPORATION

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GAGES • MEASURING INSTRUMENTS • MACHINE TOOLS • CONTRACT SERVICES • THREADING TOOLS

Another Industrial Leader...

LOCK JOINT Pipe Company

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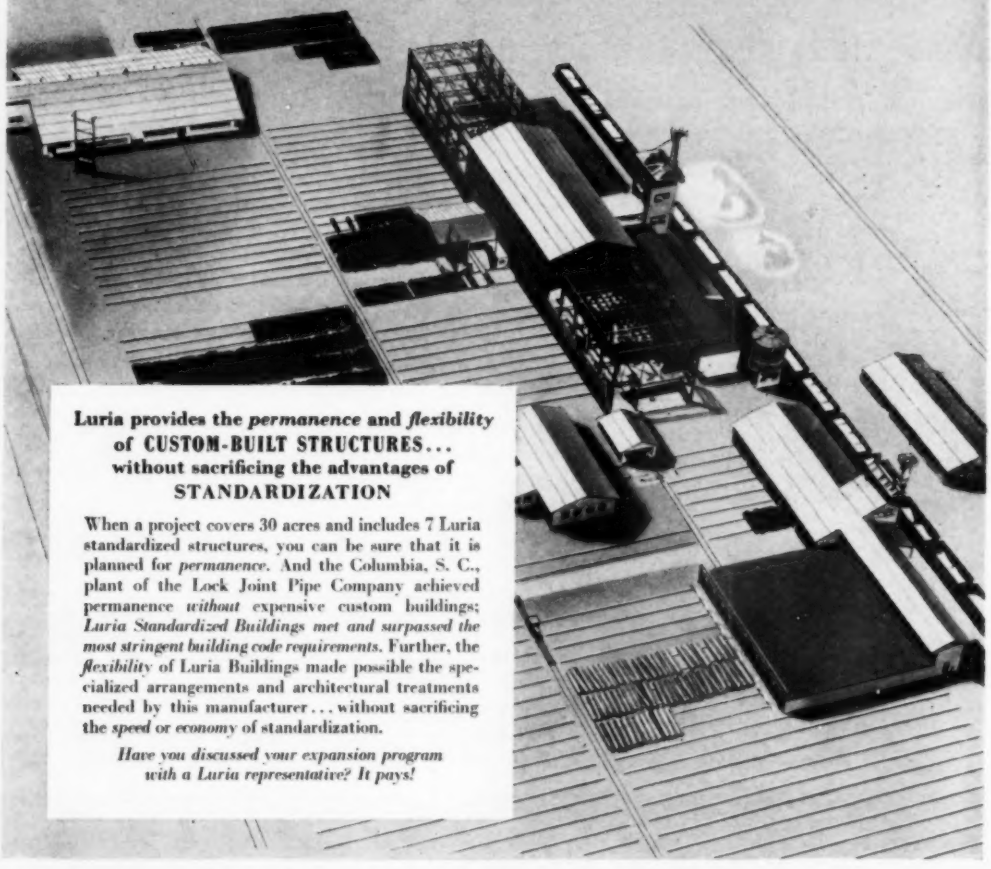
LURIA Standardized Buildings



Luria provides the *permanence* and *flexibility* of CUSTOM-BUILT STRUCTURES... without sacrificing the advantages of STANDARDIZATION

When a project covers 30 acres and includes 7 Luria standardized structures, you can be sure that it is planned for *permanence*. And the Columbia, S. C., plant of the Lock Joint Pipe Company achieved permanence *without* expensive custom buildings; *Luria Standardized Buildings met and surpassed the most stringent building code requirements.* Further, the *flexibility* of Luria Buildings made possible the specialized arrangements and architectural treatments needed by this manufacturer... without sacrificing the *speed* or *economy* of standardization.

Have you discussed your expansion program with a Luria representative? It pays!

LURIA ENGINEERING COMPANY

500 FIFTH AVENUE, NEW YORK 36, N. Y.

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Portrait of an Achievement

The illustration above represents a significant milestone in the development of improved new methods of ordnance manufacture. It is a copper shaped-charge component deep-drawn to a wall tolerance of .001".

The precision deep-drawing method developed by Eastern Tool & Mfg. Co. permits fast, accurate production of ordnance components in a variety of metals, a great improvement over the slow, tedious machining methods formerly used.

Although the deep-drawing facilities of Eastern Tool & Mfg. Co. are at the present time fully occupied with ordnance manufacture we welcome inquiries from interested manufacturers.

Send for our new descriptive booklet No. 100.

Eastern Tool & Mfg. Co. press lines deep-drawing two sizes of shaped-charge components.

Eastern

TOOL & MFG. CO.

Wire Forming • Metal Stamping • Deep Drawing

Belleville 9, N. J.

Pioneers in Precision Deep-Drawing for Ordnance

SILECTRON C-CORES... BIG or LITTLE

...any quantity and any size

Wound from precision rolled oriented silicon steel strip as thin as .00025"

WDD 4363

For users operating on government schedules, Arnold is now producing C-Cores wound from ¼, ½, 1, 2, 4 and 12-mil Silectron strip. The ultra-thin oriented silicon steel strip is rolled to exacting tolerances in our own plant on precision cold-reducing equipment of the most modern type. Winding of cores, processing of butt joints, etc. are carefully controlled, assuring the lowest possible core losses, and freedom from short-circuiting of the laminations.

We can offer prompt delivery in production quantities—*and size is no object, from a fraction of an ounce to C-Cores of 200 pounds or more.* Rigid standard tests—and special electrical tests where required—give you assurance of the highest quality in all gauges. ● *Your inquiries are invited.*

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

It climbs like a billy goat,
Pulls like an ox;
Ordnance planners
Were smart like a fox.

(Definitely an "EAGER BEAVER")

REO MOTORS, INC., LANSING 20, MICHIGAN

One for all

at the GLENN L. MARTIN COMPANY...

it's the REMINGTON

Electri-conomy

typewriter for their

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SPECIFICATIONS BLUEPRINTS
CHARGE ORDERS BILLS OF MATERIALS
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DATA SUMMARIES

A veritable stream of paperwork starts flowing the very second Glenn L. Martin Company receives a contract to design and build a plane. Preparing all this paper may well be compared to the actual building of the plane... *standardization, quality, accuracy, uniformity and interchangeability are all of paramount importance.* That's why you will find Remington Electri-conomy typewriters at work throughout the Martin plant in Baltimore.

Increased typing production . . . handsome, uniform typescript... 16 or more crystal clear carbon copies at *one* typing... sharp, clean stencils . . . and a new high in operator morale because of its amazing electric ease of operation are just a few of the many Plus-Values to be experienced with the Electri-conomy.

Send for FREE Booklet, "TAKE A LETTER" (RE 8499). Address requests Room 2575, 315 Fourth Ave., New York 10.

Remington Electri-conomy Typewriters at work at the Glenn L. Martin Co.

Remington Rand INC. THE FIRST NAME IN TYPEWRITERS

Looking For Machines To Help Do A Better Job....

THE CLARK DRIVE UNIT

Here's an interesting and commendable record: Every machine—agricultural or industrial, new or modernized—equipped with a CLARK designed transmission-axle driving unit is performing with efficiency and dependability.

This shouldn't surprise anyone—for CLARK brings to the assignment a seasoned and resourceful engineering experience that goes back 35 years.

The Clark Drive-Unit is on the lookout for heavy duty machines that might well benefit from a closer acquaintance.

This pocket size book briefly describes and illustrates Clark Products. You are invited to send for it.

PRODUCTS OF CLARK — TRANSMISSIONS • AXLES • AXLE HOUSINGS • TRACTOR DRIVE UNITS • FORK TRUCKS AND TRACTORS • POWERED HAND TRUCKS • GEARS AND FORGINGS • ELECTRIC STEEL CASTINGS

CLARK EQUIPMENT COMPANY • BUCHANAN, MICHIGAN

Other Plants: BATTLE CREEK *and* JACKSON, MICHIGAN

Squeezed like an accordion, welded tubing demonstrates uniform strength

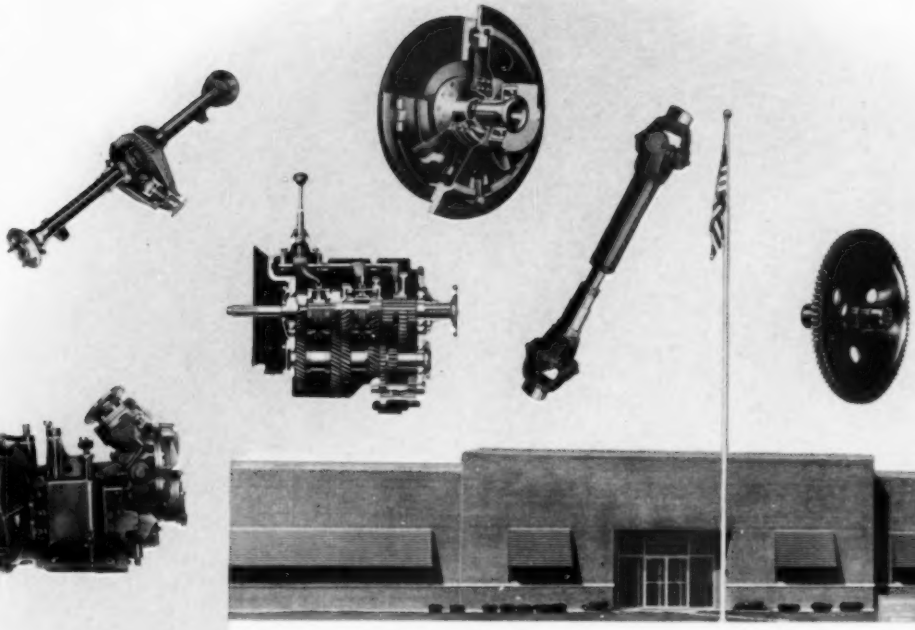
● This compression folding of a section of electric-welded steel tubing produces no cracks or flaws. Such uniform strength is proved in many other severe cold forming operations. U. S. Bureau of Standards tests show that the weld is as strong as the wall, and that it has the same qualities as the steel.

Investigate the economy and physical advantages of Brainard welded steel tubing in *your* products. Write Brainard Steel Division, Dept. EE-1, Griswold Street, Warren, Ohio. An integrated producer; offices throughout the U. S.

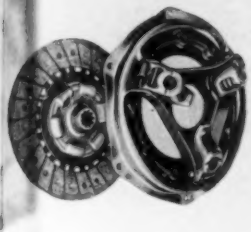
Brainard
SHARONSTEEL
STEEL DIVISION
SHARON STEEL CORPORATION

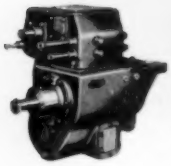
WELDED STEEL TUBING

now we are ten
Now there are 10 modern plants in the Dana group of industries serving the automotive and aircraft fields. The addition of two new plants is symbolic of the sound and steady growth of this diversified American corporation. Look to Dana and Spicer for excellence in engineering . . . careful manufacturing . . . and everyday well-managed administration of service.
Spicer



meet marion and fort wayne no. 2





The new Marion Manufacturing Division plant of Dana Corporation is producing the famous Spicer Needle-Bearing Universal Joint and Propeller Shaft assembly so widely used for automobiles, trucks, buses, and tractors.

The new Aircraft Gear Division at Fort Wayne, Indiana, is the second Dana plant to be erected in that city. It is producing highly specialized power transmission units with a background of Spicer precision, which for nearly 50 years has been the *Standard of the Industry*

SPICER MANUFACTURING DIVISION *of Dana Corporation* • **TOLEDO 1, OHIO**

49 YEARS OF Spicer SERVICE

ENGINEERING DANA MANUFACTURING

TRANSMISSIONS • UNIVERSAL JOINTS • BROWN-LIPE AND AUBURN CLUTCHES • FORGINGS • PASSENGER CAR AXLES • STAMPINGS • SPICER "BROWN-LIPE" GEAR BOXES • PARISH FRAMES • TORQUE CONVERTERS • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES

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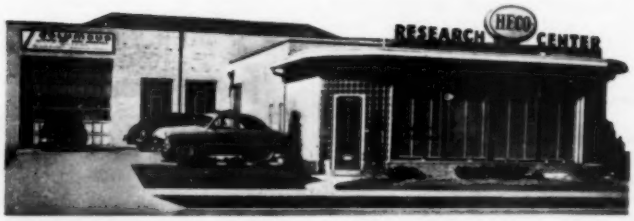
SHELLS
FUZES

and other ammunition metal components assures the armed forces of highest quality, delivery as promised and fair price.

HECKETHORN MANUFACTURING AND SUPPLY COMPANY

Littleton, Colorado

Contractors to the United States Armed Forces for Rockets, Shells, Fuzes, Research and Development



HECO RESEARCH CENTER—This new experimental and testing laboratory is located in South Denver, apart from the main plant.

Its alert staff and modern equipment will enable the company to broaden and increase its activity in ordnance research and development.

MATERIALS-HANDLING NEWS

★ Panel Discussions by Bassick, World's Largest Manufacturer of Casters and Floor Protection Equipment ★

Casters Equipped With These Conveniences Make Materials-Handling Easier, More Economical

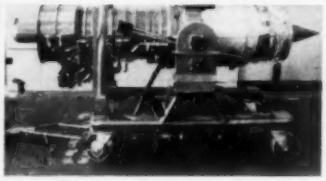
Plunger-type Lock Prevents Swivel From Operating

Sometimes it's desirable to keep a caster from swiveling. For such applications, there are many standard Bassick Casters which can be supplied with the easily operated plunger-type Swivel Lock. Complete flexibility in handling operations, for close quarters or long hauls.

Locking Is Sure With This Wheel Brake

In some kinds of materials-handling operations, a simple mechanism is needed to keep a wheel from turning. There's no substitute for the sure-holding action of Bassick's hand-operated Side Wing Brake.

Exclusive Sprung-Wheel "Floating-Hub" Absorbs Materials-Handling Shocks



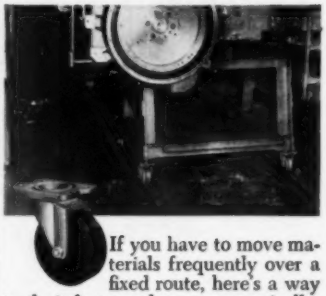
Loads are more safely and easily moved over rough surfaces when carried in equipment rolling on Bassick "Floating-Hub" Casters.

This patented construction actually "floats" a spring-controlled caster wheel in the frame, providing mechanical resiliency between rim and axle. Even over bumps, all wheels keep in contact with the floor. Hence, load distribution is always even. That's why Bassick's "Floating-Hub" means sure protection for highly-finished auto bumpers, ceramic products, glass and china ware, loose loads of small precision parts and innumerable fragile loads.

Hold Portable Equipment In Fixed Position With This Position Lock

Install Bassick Position Locks on portable equipment, and you can hold it in position with an easy, downward press of the lock's foot lever. This action places almost 12 sq. in. of friction locking surface in contact with the floor. A slight upward pressure under the lock's lever releases it.

Boost Materials-Handling Efficiency With Grooved Wheels on Angle Track



If you have to move materials frequently over a fixed route, here's a way to do it faster and more economically.

Equip trucks and dollies with Bassick Grooved-Wheel Casters and move them on inverted angle iron track. By doing so, you control movement along the route with production-line efficiency, and also make movement three times easier than flat wheels in direct contact with the floor.

Angle iron track is easily installed, inexpensive, self-cleaning. Bassick Grooved-Wheel Casters operate on the track or in direct contact with the floor.

They come in 4, 6, 8, 10 in. sizes, swivel or rigid.

Write for full details — no obligation

Write us for full data on any of the products discussed here, or information on any Bassick Caster. Bassick makes the world's largest line with the sizes and types for everything you wish to move easily, quietly, efficiently. Consult your local Bassick industrial distributor for expert advice, backed by our factory engineering assistance when needed.

THE BASSICK COMPANY
Bridgeport 2, Conn.
In Canada:
Belleville, Ont.

Bassick
A DIVISION OF STEWART SW WARNER

MAKING MORE KINDS OF CASTERS... MAKING CASTERS DO MORE

Deep-sea dog fight

Our sea battles of the future may be fought by high-speed submarines on the eeriest battleground of all time—deep beneath the sea. For the first time in naval history submarines are now being designed expressly to track and destroy other submarines while totally submerged.

The detection and missile-guiding systems which make this possible are the result of bringing the magic of electronics to problems of automatic control and computation too complex for rapid solution by man. Working closely with the Armed Forces for 34 years, Arma Corporation has played a leading part in this field in basic research, design, development and production.

Electronics provides a whole new arsenal of defense weapons. In important areas of this field Arma is pacing the developments. *Arma Corporation, Brooklyn, N. Y.; Mineola, N. Y.; Subsidiary of American Bosch Corporation.*

ARMA ADVANCED ELECTRONICS FOR CONTROL

AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet
Subject: HOW *GRANODIZING* PROTECTS STEEL DRUM SURFACES FROM RUST AND IMPROVES PAINT ADHESION

NEW DEVELOPMENT IN CONTAINER INDUSTRY

United States Steel Products Division, United States Steel Company is now producing grease-free, scale-free, rust-inhibited steel drums. A chemically clean metal surface plus a "Granodine" non-metallic zinc phosphate coating insures maximum finish durability and underpaint rust-resistance.

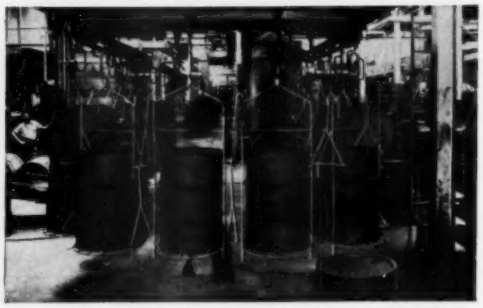
ORDINARY PAINTED DRUM after a year of exposure to weather is badly rusted. Rust was very apparent after only one week.

U. S. S. RUST-INHIBITED DRUM of similar type shows absolutely no rust after same year's test.

THE PROTECTIVE CHEMICAL TREATMENTS

The Granodizing process embodies the following steps:

1. Grease and dirt removal
2. Full scale removal, after welding the side seam
3. Zinc phosphate coating with "Granodine"
4. Acidulated rinsing in "Deoxylyte" solution



Port Arthur, Texas, Cleaning Line

U. S. S. drums about to enter the 400 foot cleaning and treating line. Powerful impingement sprays directed at the fabricated shell, head, and bottom, insure that the entire interior and exterior of the drum will receive full cleaning and rust-inhibiting treatment.

ADVANTAGES OF GRANODIZED STEEL DRUMS

These new phosphate-coated steel drums exhibit many advantages for companies using these containers.

They are chemically clean, "water-break free" inside, free of contaminating residues such as grease, oil, drawing and stamping compounds. When the familiar handkerchief test is applied to United States Steel Products' containers processed by their new finishing technique, no contamination of any kind is left on the cloth.

They are free of mill-scale. United States Steel Products is the first steel drum manufacturer to remove harmful mill scale completely ahead of the zinc phosphate coating stage.

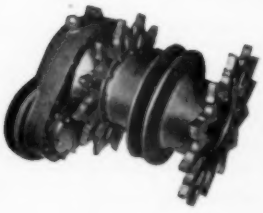
They are rust-inhibited with a zinc phosphate-coating. These new steel drums have the added advantage of a non-metallic, paint-bonding "Granodine" zinc phosphate coating. This has been standard practice for many years in the automotive and appliance industries for long-lasting paint protection and metal preservation.

CHEMICALS ACP PROCESSES

WRITE FOR INFORMATION ON "GRANODINE" AND ON YOUR OWN METAL PROTECTION PROBLEMS

CHEMICALS ACP PROCESSES

Final Drive Assembly for M-47 Medium Tank



Prime Contractor:

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Just one example of what Oliver is doing . . . evidence of the facilities at your command.

THE OLIVER CORPORATION

OLIVER

The OLIVER Corporation, 400 West Madison Street
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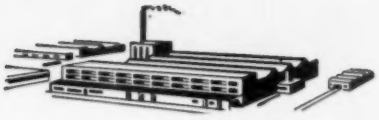

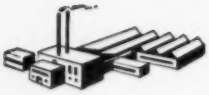

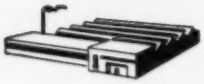

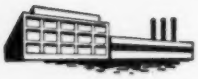

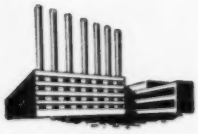

PRODUCTS and FACILITIES Serving Many Industries

Pressed Steel Car Company offers a broad range of products and services available to industry throughout the world. Always alert to new processes and technological advances Pressed Steel Car Company throughout the years has maintained a reputation for more efficient, higher quality products.

ALL OUTSTANDING PERFORMERS — ***these products range from . . . . . .***

- *Locomotives and trackwork to cookware*
- *Agricultural and farm machines to milk cans*
- *Railroad and industrial cars to oil pumping machinery*
- *Industrial trailers and engine lathes to conduit fittings*
- *Steel tanks to milk can washing machines*
- *Power plants to cellular laminated containers and shelters*

PRESSED STEEL CAR COMPANY INCORPORATED

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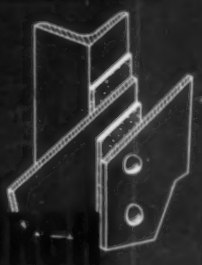
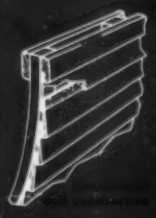
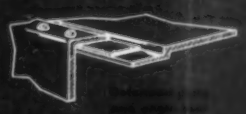
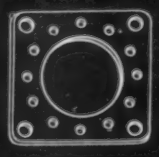
For better insulation . . . weat[illegible] waterproofing . . . and resistan[illegible] galvanic corrosion . . . . . use PITTSBURGH

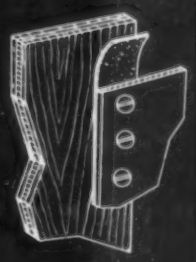
Nu-CHROMSEAL TAPE











MORE AND MORE production executives in many industries are turning to Pittsburgh's Nu-Chromseal Tape to seal lap joints or butt seams in metal, wood or fiber, where rivets, bolts or screws are used.

● **Nu-Chromseal Tape** is a solid, pliable compound of fixed width and thickness of unusual versatility. It can be used for weatherproofing of roof and side panels of motor buses; for caulking around fender-to-body seams of motor cars; in various seams of marine craft, for sealing water, gasoline and oil storage tanks; and as a galvanic insulator between dissimilar metals to prevent corrosion. It is also an excellent anti-squeak or anti-chafe medium between wood or metal members which have a tendency to rub.

● **Nu-Chromseal** is gently adhesive so that it can be readily applied under rapid production conditions. It can be used on units where baking temperature runs as high as 375 degrees, without bleeding or materially changing in character. Its pliable consistency permits easy tailoring—excess material can be readily trimmed.

Pittsburgh also offers WELDSEAL and FABSEAL Tapes

● **Weldseal** Tape protects spot-welded and hot-riveted assemblies from corrosion by sealing seams against moisture.

● **Fabseal** Tape is an impregnated fabric that forms a complete seal between wood, metal or fiber members.

Samples of these remarkable tapes are available on request for experimental work. Our engineers will be glad to consult with you without charge or obligation.

PITTSBURGH PLATE GLASS COMPANY—Industrial Paint Division; Pittsburgh, Pa. Factories: Milwaukee, Wis.; Newark, N. J.; Springdale, Pa.; Atlanta, Ga.; Houston, Texas; Los Angeles, Calif.; Portland, Ore. Ditzler Color Division, Detroit, Michigan. The Thresher Paint & Varnish Co., Dayton, Ohio. Forbes Finishes Division, Cleveland, Ohio. M. B. Suydam Division, Pittsburgh, Pa.

PPG PITTSBURGH PAINTS

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PITTSBURGH PLATE GLASS COMPANY

For over a decade
our entire organization and facilities
have been devoted exclusively to
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FLARE AND SIGNAL MUNITIONS
PHOTOFLASH MUNITIONS
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AERIAL PRODUCTS, Inc.
ELKTON, MARYLAND

Valuable Manual

shows how

creosoted timber piles save money... assure permanent foundations

● Here's a book every engineer should have. It's filled with interesting facts. Graphic descriptions. Photographs of modern construction projects, large and small, that are founded on pressure-creosoted piles.

An interesting book, yes—but informative, too. Case histories tell how substantial savings have been effected and unusual construction problems have been solved by founding permanent structures on creosoted timber piles.

You'll find this book a valuable reference. Send for a copy today. There's no obligation involved.

KOPPERS **PRESSURE-TREATED WOOD**

KOPPERS COMPANY, INC. · Pittsburgh 19, Pa.

GITS Unit* SEAL
Now STANDARDIZED

For . . .

Gear Reduction Units
Aircraft Reciprocating Engines
Automotive Accessories
Jet Propulsion Units
Washing Machines
Standard & Special Machine Tools
Electrical Power Equipment
Business Machines

*Cartridge Seal . . . pressure balanced . . . requiring only 25% more space than lip-type seals.

If *you* have a shaft sealing problem, Gits experience in these and many other specific applications can prove of great and immediate value to you.

Write today for FREE illustrated Brochure, or send us your seal problem.

GITS BROS. MFG. CO.

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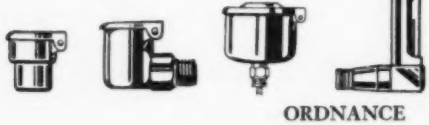
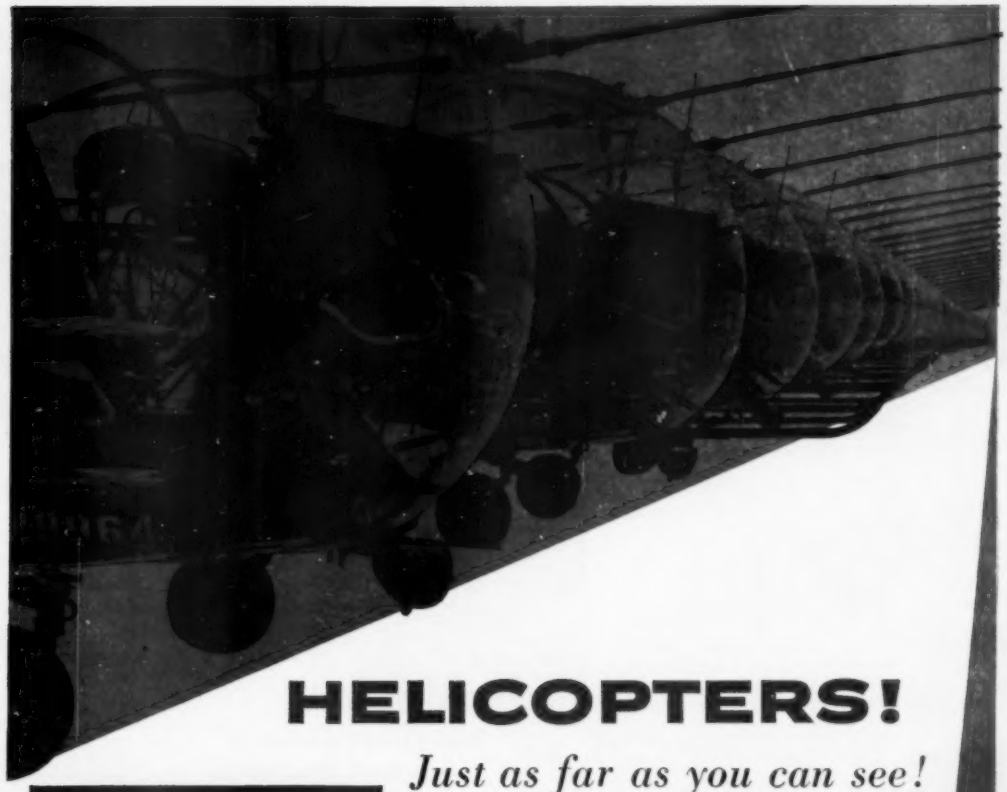
Gits Lubricating Devices,
The Standard For Industry For Over 40 Years

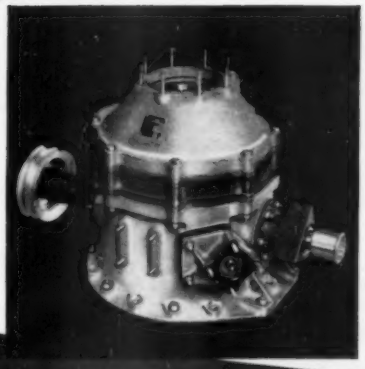




HELICOPTERS!

Just as far as you can see!

And with our precision gears they do the most amazing things!



A lot of the performance in terms of smooth even power is due to the precision-made Rotor Transmission Manufactured by the Steel Products Engineering Company for the Bell Aircraft Corporation.

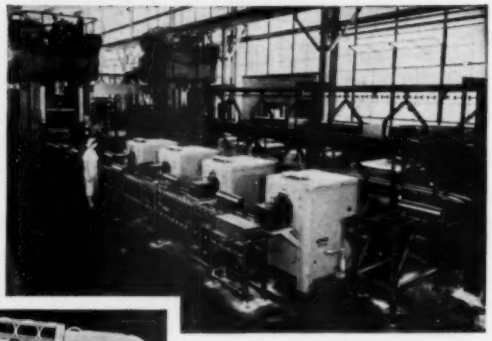
For 38 years we have been designing and producing gears, gear assemblies, and other components which have the highest possible precision characteristics.

THE STEEL PRODUCTS ENGINEERING CO.

engineers and manufacturers • Springfield, Ohio

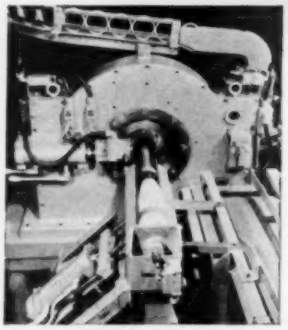
Ordnance Machinery by W. F. & JOHN BARNES

Here are only a few of the pieces of equipment built by W. F. and John Barnes for ordnance. In addition to many other individual pieces we have designed and built an entire plant for the automatic production of 155 mm high explosive shells. Other projects of similar magnitude are now in progress. We will be glad to work with you on any machining or processing problems pertaining to ordnance.



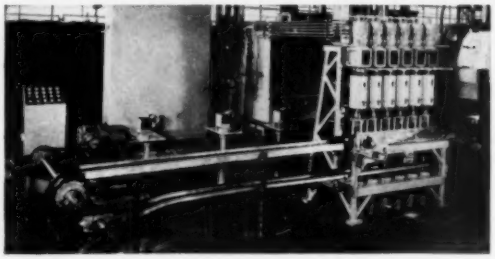
Shell Banding Machinery

Banding equipment is available for a wide variety of shell sizes. The photograph illustrates a 105 M/M shell ejected from the banding head and ready to be automatically transferred to a take-away conveyor. The automatic features and gentle handling methods of the Barnes Banding Machine has permitted successful banding of live ammunition in renovation programs. Notching heads, band resizers, band gaging units, band deburring equipment and conveyors have been developed as accessories to insure correctly banded shells. New shells can be banded at rates up to 300 shells per hour. The machines are also capable of banding shells where specifications call for a minimum content of metal in the band.



Special Conveyors

Special conveyors of all types have been designed for various processing arrangements. The illustration above represents but one example. Note the three different types of conveyors. In addition, we design and build all types of chip conveyors.



Cavity Facing Machinery

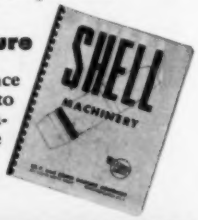
Other developments for ordnance work include machines for facing the explosive shell charge. This equipment can be furnished to accommodate shells from the 57 M/M to the 8 inch including 2.36, 3.5, 4.5 rockets, and the 4.2 mortar. Complete hydraulic operations, an absence of electrical controls and motors within the barricaded cubicle and full safety interlocks have eliminated the need for an operator inside the hazardous area. Signal lamps are included to inform the operator of the machine's performance. The machine shown was designed for the 3.5 rocket. The Barnes transfer fixtures which carry groups of six rockets through the facing operation are used throughout the load line for other operations.

Electrical Circuits and Controls

Complete electrical circuits and controls have been designed by W. F. and John Barnes for a wide variety of installations. Shown to the right is the control desk. The desk has switches and pushbuttons for manual operation in regular or special sequence when desired. Manual switches also permit sectionalizing the machines so that only certain parts will work if desired. Lamps on the vertical face of the desk burn bright or dim in sequence to keep the attendant informed of the status of the machines functions and to give notice of any misoperation.

Free Additional Literature

is available on all Barnes Ordnance equipment. Since it is impossible to give the complete scope of operation in this restricted space, we invite you to write for the complete Barnes Ordance book. Ask for bulletins 0-153.



W. F. and JOHN BARNES

PROCESS EQUIPMENT DIVISION 320 SOUTH WATER STREET, ROCKFORD, ILLINOIS

THE INDUSTRY'S FINEST POWER BRAKING SYSTEMS

on Highways Everywhere!

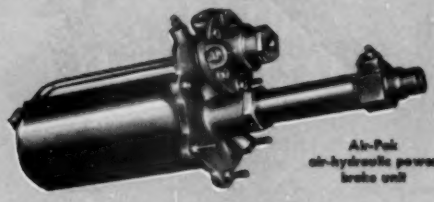
Regardless of the size of vehicle or whether the preference is for vacuum or air, the trucking industry has come to look to Bendix Products as the one source uniquely qualified to meet every power braking need.

Hydrovac, the world's most widely used power brake, is the undisputed leader in the vacuum-hydraulic field. And Air-Pak is recognized as foremost in the field of air-hydraulic power braking units.

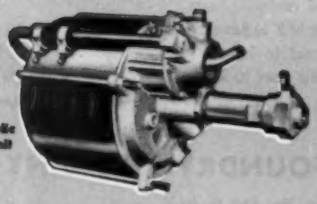
Products of twenty-five years of practical braking experience, these outstanding power braking systems offer faster, more positive and better controlled braking. And in *both* the vacuum and the air actuated units, brakes can be applied instantly by foot power *alone*—a constant safety factor of tremendous importance.

That's why on highways everywhere the preference is for Bendix® Hydrovac® or Bendix Air-Pak, the Industry's Finest Power Braking Systems.

®REG. U. S. PAT. OFF.



Air-Pak air-hydraulic power brake unit



Hydrovac vacuum-hydraulic power brake unit

BRAKING HEADQUARTERS for the AUTOMOTIVE INDUSTRY

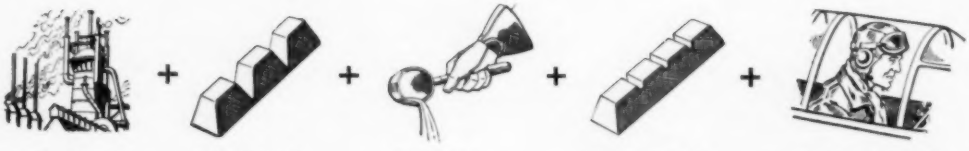
BENDIX · PRODUCTS DIVISION · SOUTH BEND

Export Sales: Bendix International Division, 72 Fifth Ave., New York 11, N.Y. • Canadian Sales: Bendix-Eclipse of Canada, Ltd., Windsor, Ontario, Canada

Bendix Aviation Corporation

Bendix Products Division

What it takes to make an "angel of mercy" fly!



Steel: 6832 lbs. + Aluminum: 3588 lbs. + Copper: 514 lbs. + Magnesium: 345 lbs. + Hours of Flight Training: 360

Hundreds of downed American airmen have known the thrill of seeing a helicopter appear suddenly from nowhere...to pluck them from treacherous seas, or hostile terrain.

American Machine & Foundry Company produces the twin rotors that give these flying "angels of mercy" their wings. AMF's engineering research and inventiveness are helping to pave the way for progress in the air, as well as on land, on the sea, and under the sea.

AMF is proud of its role in American industry—proud to be one of thousands of companies doing their part to keep America militarily on guard.

Above figures are given with due regard to security.

AMERICAN MACHINE & FOUNDRY COMPANY

Executive Offices, 511 Fifth Avenue, New York 17, N. Y.

AMF does it better—automatically!

CREATORS AND PRODUCERS OF ELECTRONIC AND MECHANICAL EQUIPMENT FOR THE ARMED SERVICES: Radar antennae and drive units • automatic loaders for Army and Navy weapons • elevating and azimuth mechanisms • cooling fans for Army tanks • airplane parts • mobile ovens • electronic training devices • naval ordnance • rolled and welded steel products • shell components • silver-zinc batteries • special military projects.

Logging in Oregon's Cascade Mountains

means

EXTRA PERFORMANCE

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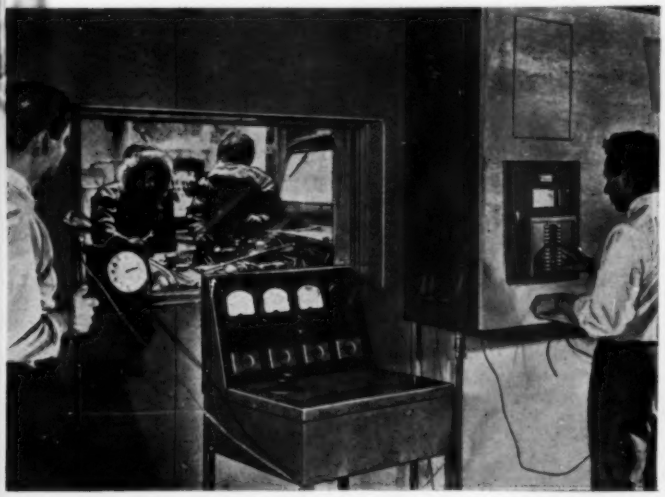

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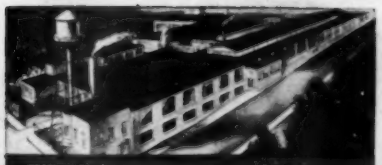

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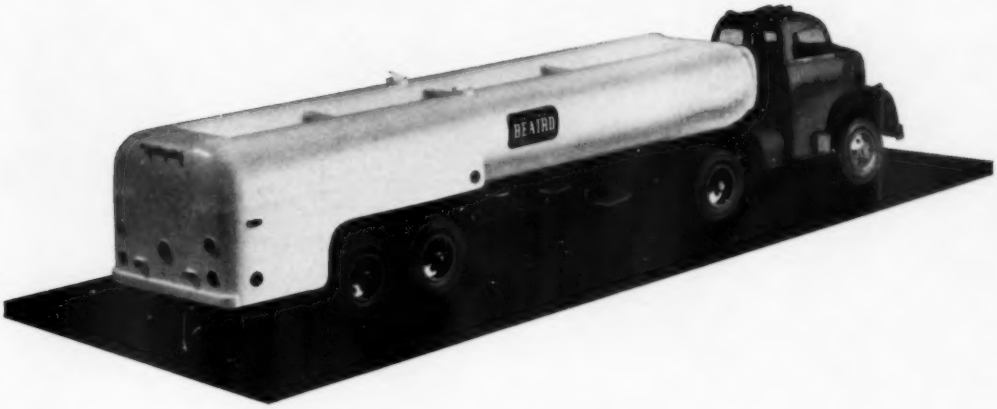
ALLIS-CHALMERS

TRACTOR DIVISION — MILWAUKEE 1, U. S. A.

Another Example of Beaird Manufacturing Skill



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Beaird has recently introduced a line of transports for LP-Gas and anhydrous ammonia liquid fertilizer. First in the line is this 5200-gallon twin-tank trailer. It has not only been engineered to stand up under long rugged service, but has been smartly styled as an attractive traveling advertisement for the dealer whose name it carries.

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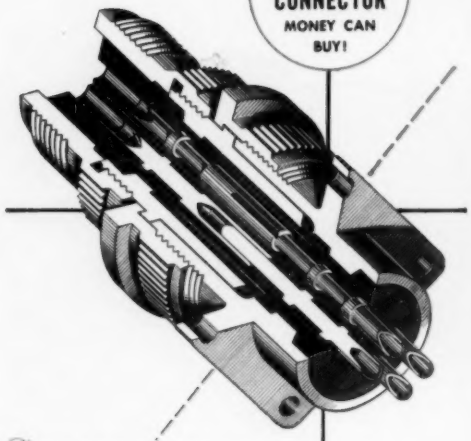

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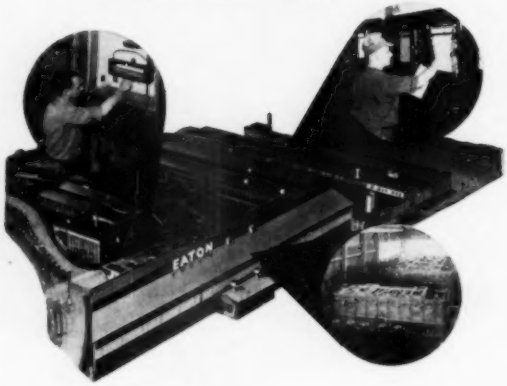

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Chrysler Siren Engineers stand ready to assist any community in planning its protection. For additional information on the Chrysler Siren and the protection required for your community, write: ***Dept. 412, Siren Layout Service, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***

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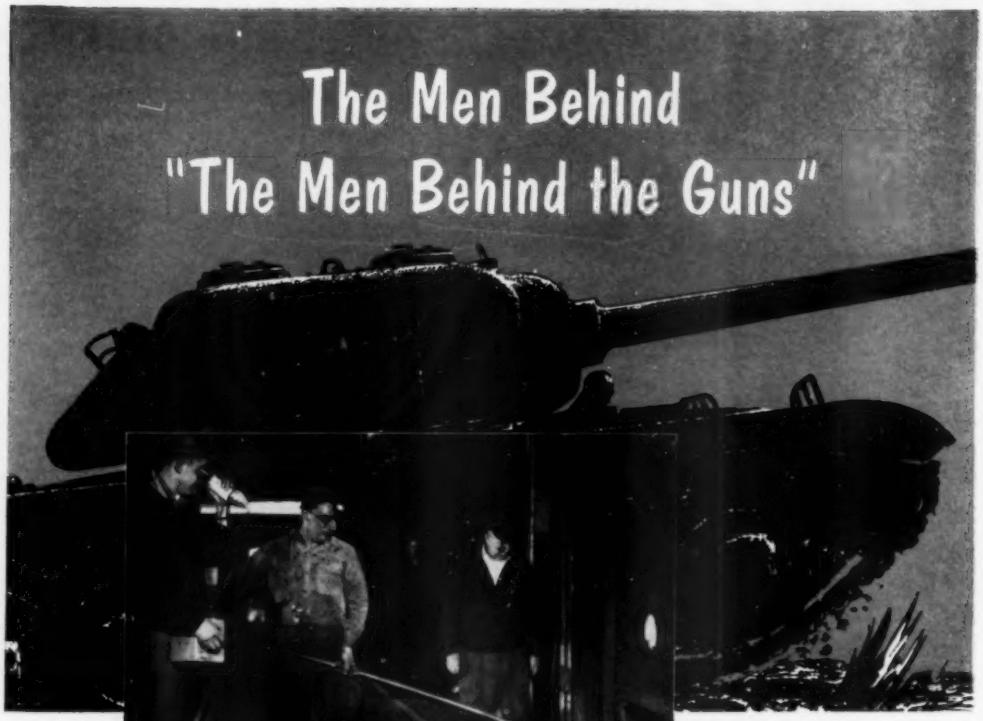
Defense is a vital need, shared by all. Join and assist the Civil Defense group in your area.

The Men Behind "The Men Behind the Guns"



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ATOMIC ENERGY

URANIUM PROCESSING

What does the Atomic Energy Commission do with the uranium ore we buy from the Colorado Plateau, from Canada, from the Belgian Congo, or from other sources? First of all, we refine the ore. Then the refined product is divided into two streams. One is converted into uranium hexafluoride and goes to the isotope-separation plant at Oak Ridge. The other is converted into metallic uranium and goes to the plutonium plant at Hanford. These conversion processes are complicated and costly but not particularly novel in kind.

The Oak Ridge plant is entirely novel in character since no separation of isotopes on an industrial scale had ever been achieved before it was built. I will not describe the process but merely remind you that the product of the process is Uranium 235.

Once we have obtained Uranium 235, we fabricate most of it into parts for atomic bombs. We use some of it as atomic fuel for very special reactors built for experimental purposes, and we expect to use more for the production of power where the advantage of this highly concentrated fuel outweighs its very great cost. Natural uranium is unsuitable for any of these purposes.

Unique Plant

The Hanford plant in the State of Washington is again unique and unprecedented. It consists of nuclear reactors using uranium metal with its natural mixture of Uranium 235 and Uranium 238. Fission occurs in the Uranium 235, and the neutrons from that fission produce plutonium in the Uranium 238. The plutonium is then separated from the surrounding mixture by chemical processing.

The energy released by the primary fission of Uranium 235 is, unfortunately, wasted at the present. In fact, one of our greatest problems in the Hanford plant is to get enough of the Columbia River flowing through the reactors to take away the heat that is generated by the fission process. Like the product Uranium 235 from the Oak Ridge plant, the plutonium coming from the Hanford plant is fabricated into weapon parts.

Obviously what we are actually doing is a long way from the ideal breeder reactor which would convert the energy stored in both Uranium 235 and Uranium 238 into useful power. All we are doing is to extract the Uranium 235 or to use some of it to make plutonium. Why aren't we making power? Why do we even

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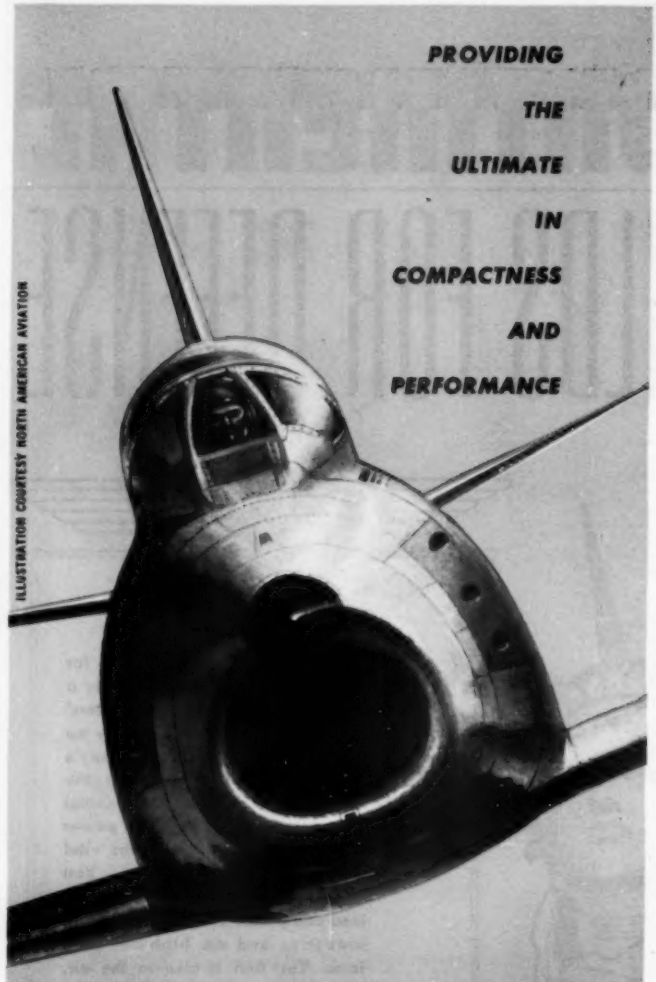

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throw away by-product power at Hanford?

Fundamentally the difficulty lies in the fact that the chain reaction does not occur as readily as was implied in my simple explanation of it. The neutrons that come out when a fission occurs in the Uranium 235 atom are not very numerous and can find lots of things to do besides producing other fission in a neighboring Uranium 235 atom. This means that the reactor has to be very skillfully designed and that the materials that can be used in it are extremely limited both in quantity and quality. Otherwise it will not run at all.

For example, it is difficult to get energy out of the Hanford reactors because they have to be run at a relatively low temperature due to the fact that aluminum tubes have to be used in the reactor, and aluminum corrodes too badly if the temperature is high.

Aluminum has to be used in the reactors because the less corrosive materials that are available absorb neutrons. Materials that absorb neutrons cannot be used because they prevent a chain reaction from maintaining itself.

Technical Problems

The first problem to be solved in making efficient use of the energy developed by a nuclear chain reactor is to build one which will operate at high temperatures. There are a number of experimental reactors that have been designed in which this problem is solved, and some of them are running. At present they all make use of enriched fuel; that is, of uranium that has more than the normal concentration of Uranium 235 in it. Most of them also use novel and expensive materials either as coolants or as structural elements of the reactors.

The enrichment of the fuel and the use of expensive materials greatly increase both the capital and operating costs of these reactors. For special purposes, such as the propulsion of a submarine, this is already worth while. We have every hope that further development will bring costs down to the point where uranium is competitive with other sources of power for ordinary use.

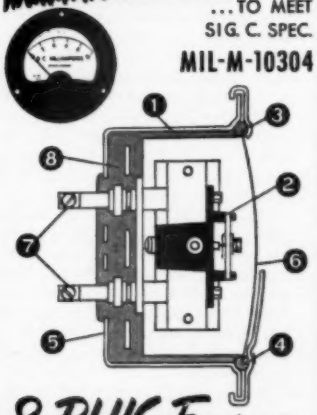
There are two obvious ways in which costs may be brought down. One of them is to build a reactor using natural uranium fuel and producing power at a relatively high cost but at the same time producing plutonium. In other words, we need to build a reactor similar to those at Hanford except that the design and materials would be so changed that they could be run at a higher temperature and power could be produced reasonably economically.

The difference between the cost of the power so produced and the power pro-

Available NOW!

RUGGEDIZED METERS

...TO MEET SIG. C. SPEC. MIL-M-10304



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2. Meter movement supported by die-cast frame for greater strength and increased accuracy.
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SUN "Ruggedized" Meters are available as D-C Volt Meters, Ammeters, Milli-ammeters and Micro-ammeters and also may be ordered as rectifier type A-C instruments.

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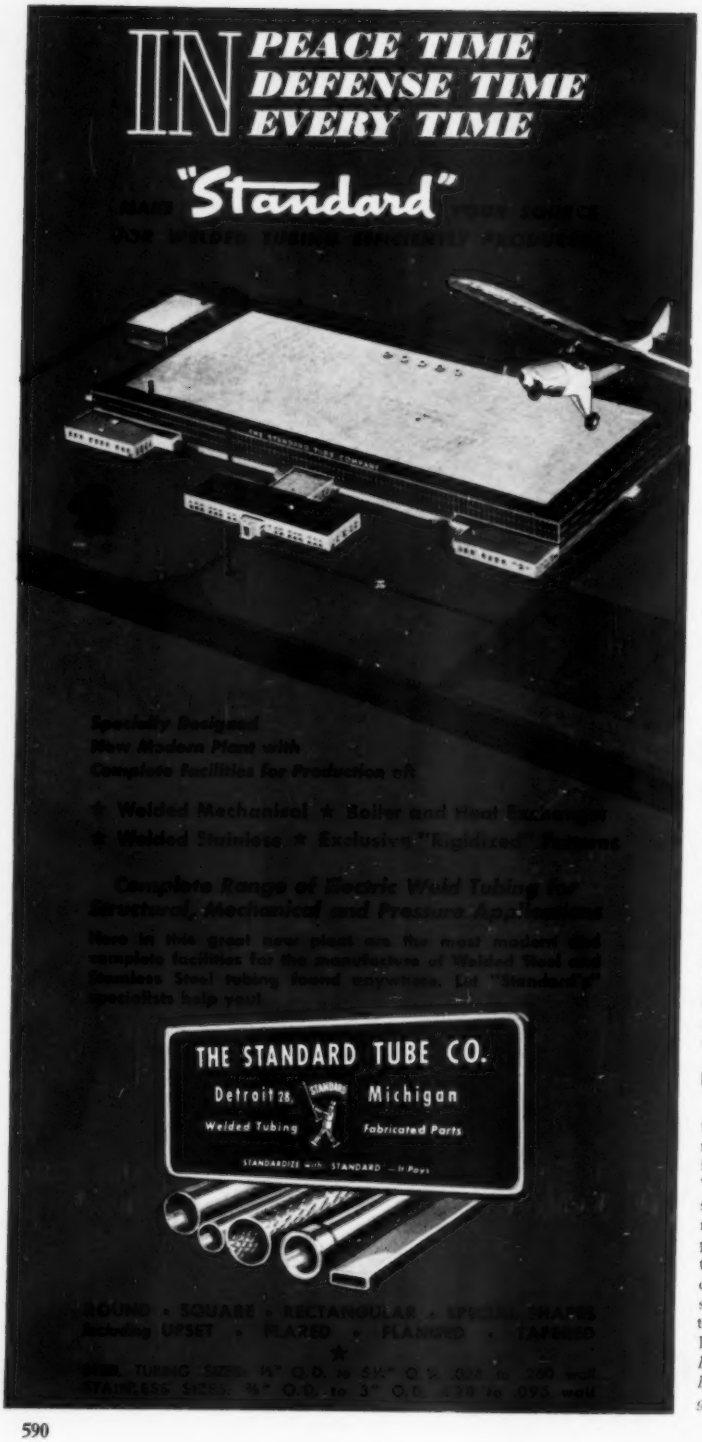

Atomic Energy

duced by a conventional coal-fired steam plant would be more than made up by the value of plutonium produced as a by-product. Obviously the crucial question for such a plant as this is the question of how much plutonium does the Government require for military purposes and how long is it going to continue to buy plutonium?

Power Breeding

The second avenue toward atomic power on an economic basis is the so-called "power breeder." Ideally, a power breeder would start with natural uranium as a fuel. As the Uranium 235 split up in a chain reaction it would furnish heat but it would also produce plutonium in the surrounding Uranium 238. This plutonium would in turn undergo fission, producing more energy and more neutrons which would again produce more plutonium in the Uranium 238, and so on.

Ideally, this process would continue until all the uranium originally present had been consumed, either in the form of Uranium 235 or plutonium. In actual practice, the reaction would be stopped before the fuel was consumed because the products of fission act as impurities to absorb neutrons and prevent propagation of a chain reaction.

If this point is approached, the fuel could be extracted, processed chemically for the removal of the fission-produced impurities, and then put back into the reactor. Probably the most important factor in the cost of operation of such a power plant would be the frequency and cost of this chemical processing to remove the fission products.

About a year and a half ago the technical people inside and outside the Commission felt that developments had come to the point where a serious study should be made of the possible feasibility of building nuclear power stations on an economically competitive basis. The Commission arranged with four groups of companies to carry out such studies.

Different Viewpoints

It is very encouraging that each of these four groups has now submitted preliminary reports and each of them is greatly interested in pursuing the subject further. Their points of view differ considerably—some of them feel that they are nearly ready to build plants in areas where power is now costly; others are looking toward the more distant future but feel convinced that they can make radical steps in the technology which will eventually bring a real reduction in cost.—HENRY D. SMYTH, *United States Atomic Energy Commission, before the Western Division of the American Mining Congress, Denver, Colo.*

Whiz Specification Corrosion Preventive Compounds for Government Contractors

Specification Number	Trade Name
MIL-C-972, Grade I (Superseding 52-C-18 Grade I)	Klad Kote 101
MIL-C-972, Grade II (Superseding 52-C-18 Grade II)	Klad Kote 122
MIL-C-6708, Type I (Superseding AN-C-52b Type I)	Klad Kote 102
MIL-C-6708, Type II (Superseding AN-C-52b Type II)	Klad Kote 252
AN-C-124a, Type I	Klad Kote 124
AN-C-124a, Type II	Klad Kote 224
AXS-673, Rev. 2	Klad Kote 103
AXS-1759, Grade I	Klad Kote 171
AXS-1759, Grade II	Klad Kote 172
AAF 14156, Amend. 1	Klad Kote 356
USA 2-122	Klad Kote 322
USA 2-121	Klad Kote 221
AN-VV-C-576b, Type I	Klad Kote 376
AN-VV-C-576b, Type II	Klad Kote 378
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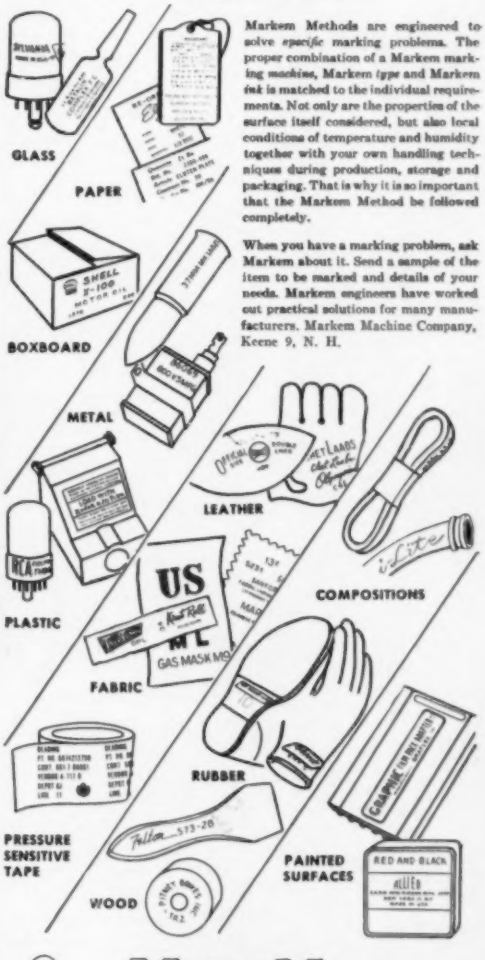

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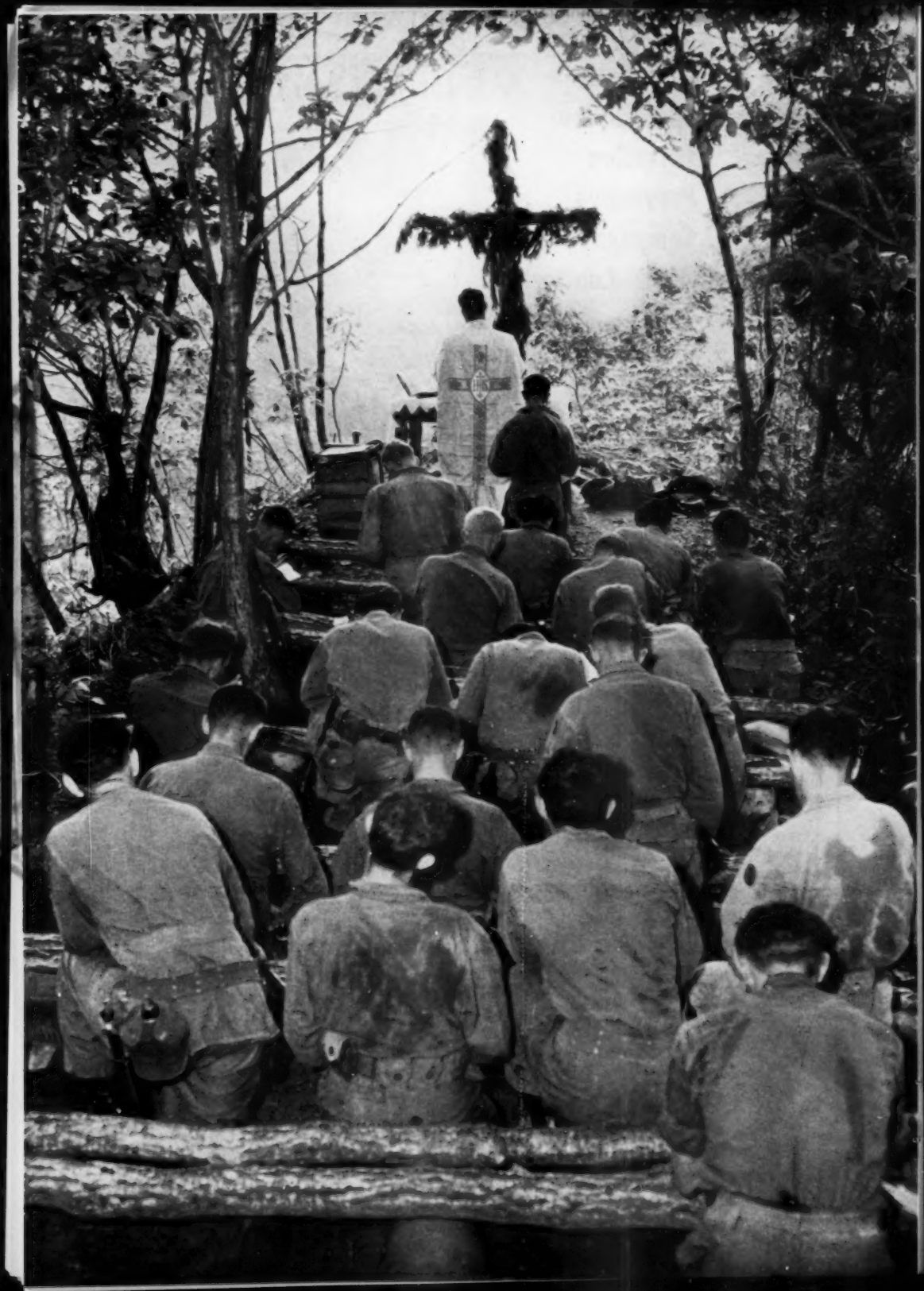


A New Approach to Preparedness

The High Command Is Skilled in the Art of Mobilization

AS General Eisenhower assumes the duties of his office there arise feelings of confidence that as Commander in Chief of our Armed Forces his vast experience will strengthen especially our military establishment both in itself and in its close affiliation with American science and industry.

Speaking for one segment of our economy, Col. Herbert A. Gidney, senior vice-president of the American Ordnance Association, at the Thirty-fourth Annual Meeting of the Association in New York on December 3, 1952, said: "We pledge to our President-elect, General Dwight D. Eisenhower, and to the Secretary-designate of Defense, Charles E. Wilson, both of whom have long been identified with our Association, our wholehearted cooperation in the cause of peace."

Efficiency in Defense

Likewise, the appointment of Charles Erwin Wilson, president of General Motors Corporation, comes with assuring indications of efficiency in the defense establishment that has characterized the operations of our greatest industrial enterprise. Mr. Wilson has been a member of the Association for many years.

In greeting these new leaders who are well versed in the complexities of industrial preparedness, cordial thanks are similarly extended to the officials of the Defense Department who are relinquishing the reins of direction. They have given the country sterling leadership under most difficult conditions—never before have our leaders had to carry such grave responsibilities in providing so many guns and so much butter simultaneously. Their record of coöperation with the American Ordnance Association is an inspiring one which members of the Association will cherish through the years.

Previews of the Eisenhower-Wilson philosophy on the needs of our national defense are most convincing. In his Baltimore address on September 25, 1952, General Eisenhower made two major proposals for the improvement of the efficiency of our vast military machine: (1) The creation of a civilian commission to restudy the operations, functions, and activities of the Department of Defense, and (2) the extension of membership on the National Security Council to "civilians of the highest capacity, integrity, and dedication to public service."

The task of the latter group, he said, "should be to design an over-all scheme of national security best suited to our inventive, productive, and military genius and to our geographic and strategic position in the world." Observers attach extreme importance to a new appraisal of the functions and composition of the Security Council.

The new Secretary of Defense has led the country in proposing a workable method of maintaining our arms-producing potential until that distant day when a healthy condition of lasting international peace exists.

Dual-Purpose Plants

The Wilson Plan for dual-purpose plants capable of producing guns and automobiles during emergency and of quick adjustment to all guns or all automobiles as conditions demand was first presented personally by Mr. Wilson at the Thirty-third Annual Meeting of the Ordnance Association in Cincinnati in October 1951. It was published in full in the January-February 1952 issue of this magazine. Since then the Wilson Plan has met with widespread study and comment.

It is reassuring to know that the defense burden will be carried upon competent shoulders supported by constant help from the entire country and especially from the members of the American Ordnance Association.

It is unnecessary to publish here, as is our custom, a short biographical sketch of the person whose photograph graces our front cover. General Eisenhower is a world figure whose life and work are well known at home and abroad by young and old alike. His ability as tactician and strategist, as staff officer and field commander, are written large in the records of our own country during the past decade and of many other countries as well.

But there is one phase of his military career which it is appropriate to stress here. The first official Industrial Mobilization Plan for our entire national economy—military as well as civilian—was presented to the U. S. War Policies Commission in the year 1931—twenty-one years ago. The plan was prepared by the Army and was presented to the Commission at public hearings by Gen. Douglas MacArthur, then Chief of Staff.

The Industrial Mobilization Plan presented by General MacArthur was the work of many minds, notably officers of the Ordnance Department of the Army and of the Planning Branch, Office of the Assistant Secretary of War.

There was extensive assistance from private industry and notably from the then Army Ordnance Association. The plan also came under the scrutiny of Maj. Dwight D. Eisenhower, then a member of General MacArthur's staff and already known for the breadth of his perception and the fluency of his pen. So he was, from the start, closely familiar with industrial-mobilization plans and learned of their importance from the best American authorities.

PEACE IN KOREA *comes for a few moments to these battle-stained men of the 7th U. S. Infantry Division, as they attend a religious service in the field (Army photo).*

The Road to Peace

Each Citizen Must Share the Responsibility for Defense

by

Charles E. Wilson

"The burden of preparedness is not just on professional military men, nor on government, but on all of us—military, political, industrial, agricultural, scientific—to integrate our respective activities and fields of interest."

ON two principal occasions in the past, according to my recollection, I have stood up before ordnance groups at their invitation and spoken my piece on this subject, which must always be very close to us and very important to our survival. Ordnance, you know, used to be a sort of special topic, to be discussed and understood and criticized only by experts and professionals, just as war itself used to be reserved for the professionals. Even taxes, as a subject of enlightened discussion, was on the agenda of a relatively small portion of our total population.

Circumstances Have Changed

Time has certainly changed all this. The result—which puts taxes and war and weapons right in the lap of almost every American family—may be a wholesome result, but the reasons for the change have been unpleasant, costly, and tragic. War and its cost, defense and the high cost of security, have tended to make active participants of us all, even if we have not become experts in the process. Certainly I am no expert on these subjects, but you might say that my presence here is only a specific example of the great change that has come into our lives.

Views Not Altered

As is only natural, I looked back to those two other occasions, eight years ago and four years ago, approximately, to see what I had said to you on the subject of weapons and our preparation of them. I am afraid I must report to you that my views have not changed in the main, and that anything said here will largely be a repetition, with some editing in favor of our common trials and experiences in the meantime. I hope you feel that if something was worth saying once, it may be worth repeating.

In the years during which I have been involved in some degree in the production of weapons by private industry, and on the Government side in the planning and administration of our defense and war programs, I have always been intrigued and perplexed by the historic dilemma in which we find ourselves as a free people. That dilemma is posed by the command: "Prepare to defend yourself."

If we are going to continue to exist, obviously we must defend ourselves when attacked. In the modern world even more than in ancient times the emphasis is on intelligent preparation for that defense. In fact we have gone so far scientifically that it is plain to all of us that mere defense, in the old sense, is not enough, because our frontiers are world-wide and almost the only defense left to a nation that relies on its industrial productive power is offensive striking power.

We are caught up today in a bitter and costly instance of the application of that rule in Korea where we are fighting, spending our material substance, and sacrificing human lives on a sickening scale—and yet we are told, officially, that we are not at war. This is a technical distinction without meaning, particularly to a bereaved family, or to a wounded man, or to a prisoner of war behind the Iron Curtain.

And so we come back to the command: "Prepare to defend yourself." To prepare, we must act. But to defend ourselves, we must wait until a blow has been struck, because to do otherwise is morally wrong and diplomatically unthinkable. Time and scientific progress in the art of destruction and slaughter have made our dilemma even more unbearable.

I do not think we are yet ready, as a nation, to go over to the Roman principle of striking first and seeking to conquer and enslave the barbarians before they outnumber and overpower us. As civilized people we must wait and watch and work for peace in a cynical world, and keep our powder dry. It is just that this business of keeping the powder dry has come to be a most complex and expensive one.

Two Kinds of Attack

If it is not out of place in the argument I would like to interject here the thought that there are two ways in which we can remain on the offensive, in a very practical sense, without backsliding from our moral principles. These two kinds of attack are (1) to continue to work for peace on the diplomatic front and (2) to continue to project and extend our ingenuity on the scientific front.

I know very well that diplomacy has often led the world into war and that science has taught us new and devastat-

ing ways in which to destroy the enemy or be destroyed by him. But neither result was the main objective of the course of action, and each has within itself the cure for its evil by-products.

To explain this further, we have had good reason throughout history to become cynical about diplomacy, and its immediate connotations are not good. Yet the fact remains that, any one day's

evidence to the contrary, there are more people in responsible positions in the community of nations who honestly want peace and progress than there are those who want tyranny and war. If we did not believe that, our situation would be hopeless indeed.

Since that is so, there must always be a better chance that world conflicts and problems will be peaceably resolved by men of good will, if they keep trying, than that they will fail. Our failures are temporary, and the important thing is to keep trying.

Our taking the offensive on the scientific front is even more promising, even though it has led us to atomic weapons and other frightful and awe-inspiring tools of human destruction. Scientists and engineers are impersonal in their approach, and their interest lies first in perfecting new knowledge. But they are also members of the human race, and the greatest built-in gimmick that any human being has to insure peace is his desire to stay alive.

History Repeats

Time after time in the history of the world it has appeared that civilization was faced with destruction at the hands of barbarians possessed of a new and invincible weapon. The weapon that Cain used, and the sword and gunpowder, have all eventually produced their defensive counterparts, and atomic weapons are no different.

Even in the twentieth century men want to live in order to complete their work and enjoy their families, and the same ingenuity which produced atomic weapons can be relied upon to produce an appropriate defense, whether it be scientific or legal or social or economic. These two things—the human desire for peace and human tenacity to stay alive—are weapons upon which we can rely, even in the darkest days.

A similar idea was expressed recently by the Pulitzer prize poet, Robert Hillyer, who said in part:

"The inventive faculty of man himself has got out of hand. His ingenuity, as irresponsible as a child with toys, has pushed out blindly and ruthlessly, without any conception of beneficent order. His deadly gadgets are more terrifying than the march of constellations.

Charles E. Wilson, former Director of Defense Mobilization and president of General Electric Company, delivered this address at a meeting of the Cincinnati Post of the American Ordnance Association in Cincinnati on October 30, 1952. At this meeting he was awarded the Post's Charles L. Harrison Medal for Distinguished Service. Presentation of the medal was accompanied by the following citation:

"To you, Charles Edward Wilson

—for your knowledge of ordnance and ordnance production,
—for your unique contribution in building the Arsenal of Democracy, in munitions, in aircraft, and in ships,
—for your leadership in drawing men of great ability into national service,
—for your resourcefulness and determination in overcoming obstacles to defense production, in wartime and in peace,
—for your vision, your courage, your devotion to the national interest,
—for service indeed distinguished,

we have the honor to present the Charles L. Harrison Medal, the Distinguished Service Award of the Cincinnati Post, American Ordnance Association."

"Destructive Infant"

"Everywhere else Nature is ordering its ranks in the struggle of life against oblivion, of Being against Nothingness. The Universe is old and wise. Man is a destructive infant. Evil and destructive inventions have to be propitiated, often by human sacrifice. When the ingenuity of man catches up with his theoretical science, he will weigh more carefully the results of his contrivances. As the planets gradually fought their way out of chaos, so must the love of life direct the unruly genius of man toward an active and creative peace."

Politics and Defense

While we have faith in such an ultimate solution, we cannot wait upon it, of course, and there are things to be done. It is not surprising, especially in such a year as this, to find politics playing too large a part in this business of preparing to defend ourselves. Recently, I saw two statements of this position, apparently in sharp contrast, although perhaps not so much so when they are examined. Dr. John R. Steelman said: "Defense cannot be political." And Gen. Dwight D. Eisenhower said: "It is high time the American people learned that this military business is their business."

The editors of *Fortune*, with whom I am inclined to agree, point out that since the defense program costs more than three-quarters of all money spent by the Government, it is certainly the people's business. The armed strength of the United States is on the increase, and by year's end it will be quite substantial. Certainly we have never been so strong in "peace." The production and delivery of weapons and equipment have increased from about 300 million dollars a month in mid-1950 to about 2 billion a month now, and delivered production is rising toward the projected plateau rate of 2.7 billion a month about a year from now.

There has undeniably been mismanagement of defense, a waste of military strength and security, and a waste of dollars appropriated and spent as the services fight over their respective shares of available money, but the real question, is not whether we are getting stronger but whether we are getting strong enough for the money we are spending.

While it is true that this gigantic task of preparation should not be made to suffer as the result of any political or partisan manipulation, I think we must welcome a direct interest in the job on

the part of all the people—and the expression and implementation of that interest is truly political action. If Dr. Steelman shrinks from that interpretation, then he is wrong and the General is right.

The nature of any American's prime interest in ordnance, despite its necessary political overtones, lies in economics, in productivity, in research and engineering. We want the best weapons, enough weapons, and at the best price. That puts the burden substantially, in today's world, on private industry and not so much as you might think on the Congress, the Administration, or the military services.

Performance Necessary

All of them are selected servants of all of us, and they are charged to shape and direct the program and to appropriate the funds. But if their efforts are to pay off, they must be validated by industrial performance in all of its ramifications.

It is not necessary for any of us to beat the drum for preparedness; that idea has been sold. We have the greater and more difficult task of applying our talents and resources efficiently and with the proper foresight. This is truly a technical task. Combat is no longer a matter of sticks and stones, or of the deadly refinements of those crude weapons. It is a matter of steel and coal and oil, of great transportation systems, of factories and laboratories, of millions of men and women who wear no uniform.

A New Game

The old familiar game of counting the weapons has been discarded for a new game of comparing the weapons, and these weapons are smokestacks and power plants and mathematical formulas.

We recall the miracles of production, so-called, which broke the backs of our enemies in the last great war, but nobody can be more than sentimentally happy about being saved by such miracles. You can't stock-pile them, for one thing. Intelligent planning should make them unnecessary.

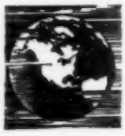
We must put into a workable and continuing harness not only the strategic and tactical tasks of the armed services, but production machinery, research, and manpower as well. Modern weapons change too fast to be locked up in any closet. We have seen the need for some kind of general-staff operation that is civilian as well as military and official in nature, if we are going to stay strong.

I have commented many times on the fact that over a quarter of a century of trial and error was involved in producing just the turbosupercharger perfected in World War II, and that was a relatively simple device, employed on those quaint, old-fashioned planes that had propellers—remember?

This serves to make a double point, I believe. First, war is no emergency job because it is too complex. Secondly, the very things that the General Electric engineers learned in perfecting the turbosupercharger, primarily having to do with alloys that would withstand extremes of temperature under operating conditions, were in themselves applicable to the design and manufacture of the jet engine—and, more important, to a score of peacetime prime-mover applications.

Diverted Interest

This was an example of the true interest of private industry diverted to wartime applications. We would never have had the result from any specific military project administered by government, for obvious reasons. The armed services, quite logically, would never have known that they *should* be interested in the gas turbine. They could not have foreseen its tremendous importance.



The burden of preparedness is therefore not just on professional military men, nor on government, but on all of us—military, political, industrial, agricultural, scientific—to integrate our respective activities and fields of interest. We have known for a long time that disarmament and unpreparedness are bankrupt as national policies, but let us not make the greater error of disassociating ourselves from the responsibility of keeping our defenses up, simply because we are civilians.

Cornerstone of Security

A continued, healthy, civilian economy—and I firmly believe a *capitalist* economy—is the cornerstone of any national-security program. This is one of the points which make political action necessary, since any government policy or action tending to supplant or destroy that kind of economy is against the national interest and should be dealt with summarily and swiftly. Some of the abuses that have been perpetrated in the name of labor and social security and government planning have seriously eaten into our ability to defend ourselves.

On the two other occasions which I have mentioned, speaking before the American Ordnance Association, I said that "it seems intelligent and essential that there be continued in time of peace the proved framework of an organization comparable to the War Production Board which will be constantly available for a time of emergency and which will draw on the store of experience, good will, production technique, research technique, and planned coöperation between the armed forces on one hand and private industry on the other. This liaison should never be allowed to die."

Six Suggestions

I don't think the liaison has died. It has been fruitful, even though not as successful as we might wish. I would like to repeat here the six suggestions made at that time.

1. Any all-inclusive program of continuing preparedness must be initiated and administered by the Federal Government, specifically by the Executive branch.

2. It must be a continuing program —not an emergency one.

3. It must be insured and supported by the Congress, through advice, legislation, and appropriation.

4. Industry must respond and coöperate—it must be *allowed* to do this, not hampered and frustrated.

5. In respect to the research and development phase, we should utilize existing facilities, and both service and

civilian groups should be represented through advisory committees in which civilian representation sharpens the natural conservatism of the services. Contact must be maintained among industrial laboratories, schools, and Government establishments.

6. In respect to the production phase, it is most important for industry to maintain permanent liaison men on all phases of national security. There should be no domination by any group in this picture, because it is too big, but there must be maximum contact and exchange. I even suggested that such assigned men be given Reserve commissions in order to regularize their status.

These suggestions, repeated here briefly, stress the importance of the production, procurement, and research phases of security, both from the purely military standpoint, and also from that of the impact of the military program upon the civilian economy. This is because the dynamic growth of modern warfare means that a comparable growth and efficiency and flexibility in the peacetime security structure is also needed.

Encourage Specialists

To repeat, it is utterly impossible to mobilize suddenly for modern war. Also, we must get our security machinery so set up that it will constantly attract the attention of specialists in private business—will compel their thinking to come out, not suppress it or discourage it.

Since those suggestions were first presented, a number of things have happened, and it is interesting to check the list against those actions. We have had a try at unification of the armed services. We have had the National Security Act of 1947 and its amendment in 1949. We have had the Office of Defense Mobilization, superimposed on the bodies set up under the law. All these things have been functioning, not without success.

To refresh your minds on the kind of task involved, I refer you to the final report of the Senate Committee Investigating the National Defense Program, established March 1, 1941, under the chairmanship of Senator Harry S. Truman and concluded seven years later under Senator Owen Brewster. In this report are the outside dimensions of wartime mobilization, production, and conversion, in case you have forgotten.

Mobilization Statistics

From an armed force of 310,000 in July 1940, we mobilized to a strength of over 12,000,000 in May and June 1945. Our civilian employed manpower increased from a peacetime force of 48,850,000 in July 1940, to a wartime high of 56,290,000 in 1943, and to an all-time high of 60,079,000 in July 1947. In all, this Nation produced $186 billion worth of munitions for ourselves and our allies during the war period. For the fiscal years 1941 through 1945 the Government spent $317,434,208,000.

A study of the legislative history of the original defense act, as evidenced by the committee's report, is enlightening in many ways. For example, in the section on labor, the report complained that too many Government agencies were mixed in the labor problem—some competing with others and none having the clear authority to announce a settlement and enforce general acceptance. It was thought desirable for these agencies and policies to be coördinated and stabilized under a single competent and experienced responsible head in order that labor policies might be uniform throughout the country.

Balance Plans

It stressed that military and production plans should be balanced against over-all manpower resources and a single head made responsible. It suggested intelligent use of draft deferment to meet critical manpower shortages in key areas, and that attention be paid to employers' hiring policies, rather than coercing the individual employee; that the General Staff check its strategy against total manpower resources to make sure an efficient balance is achieved; that attention be given to the most efficient utilization of labor, with failure to do so considered later in determining profits after renegotiation.

There were many other interesting suggestions. Over and over you find this point—that in setting up any war mobilization authority, such as the old War Production Board, *strong over-all authority must be made a living reality,* with the power to make decisions and enforce them over the objections of aggressive department heads.

Running through all the comments could be found a feeling of national unification, of balancing and coördinating the individual rôles of the military, industry, and labor. There was roughed-in here what would definitely be a permanent institution, not an emergency plan, and sight was not lost of the fact that peaceful living is still our main business, not waging war. But this was to be a peace through strength.

Important Establishment

Probably the most important establishment set up under the 1947 statute was the National Security Resources Board, the other two being the Military Establishment and the Security Council. The Resources Board would concern itself with relationships between supply and requirement in the case of manpower, resources, and production facilities in time of war. It was to study reserves of strategic and critical materials, relocation of industries, and economic activities.

Its mobilization studies included effective mobilization and maximum use of manpower in event of war; effective use of natural resources and industrial resources; maintenance and stabilization of civilian economy in time of war and adjustment to war needs and conditions; unification at such time of Federal departments and agencies concerned with production, procurement, distribution, and transportation of military or civilian supplies, materials, and products.

That was the structure, and it should have been quite an agency. We all could see that what would actually happen would depend on the personality and convictions of the individual who would man the structure. These possibilities have not been realized, I am

afraid. Instead along came another emergency, and another emergency agency, the Office of Defense Mobilization. Perhaps this is all part of our growing up under the idea of a planned security program.

Emergency Program

The Office of Defense Mobilization, of which I had the fortune or the fate to be the first Director, did not measure up too badly in the beginning to the six points stated earlier. It was initiated and administered by the Executive Branch. It was, unfortunately, an emergency program—but the emergency seems to be continuing. During my tenure of office it was supported by congressional appropriations, not to mention congressional advice. It could have done with some legislation. We had the coöperation and able response of industry. Not too much was accomplished in working out the appropriate liaison with research and production groups.

When all else is said, it put us on the road to achieving some substantial kind of military preparedness, measured by the present expenditures of $2 billion a month for weapons and equipment noted earlier. It did not hold the line on inflation, although it put up what I thought was a good fight. It could have succeeded if its strong over-all authority had been made, in the words of the Senate committee's report, a living reality. What was wrong?

The Office of Defense Mobilization was founded on a broad and complete grant of power by the President to the Director, as part of the former's emergency powers. The fatal mistake was when the President withdrew that grant in a time of crisis and test, as represented by the steel strike. This was the first thing that went wrong with ODM.

Subject to Duress

The second thing wrong was that it was allowed to become subject to duress on the part of organized labor, clearly for political purposes. The President, who could have made the agency of his own creation a success, pulled the rug out from under it in time of stress out of deference to the head of the steelworkers' union and the CIO in the year of a national election.

This leads me to suggest that some kind of statutory protection against the whims of the President himself should be given to ODM or to any future agency designed to provide a continuing national security program. No single man, who is necessarily the head of a great political party, should be put in the position that President Truman was. No President of the United States should be able to endanger the Nation's economic health or its ability to defend itself by his own act, or his failure to act, in a crisis. The Congress owes him some form of protection against any power-mad pressure group, whether it be labor or business or anyone else. We must not trust our fate to this kind of "Russian roulette."

Practical Weaknesses

Some real practical weaknesses have been discovered in the administration and management of our mobilization program. One of the greatest of these is our failure properly to assess the importance of the machine-tool designers and builders in the planning of our future armament requirements. I know that we say these things over and over, but in the final lay-down we always find ourselves in trouble. The machine-tool builders have done a magnificent job, and they will do it again. But they cannot begin to design and build the tools until designs have been frozen. And until we have the tools, nothing moves.

The armed services and the public take great encouragement from the announcement of new types of jet planes, for example, but not one can come off a line until the tools are in place. I do not foresee a time in our future when we should not be paying paramount attention to this problem.

I believe we have been acquiring valuable experience. As always, we must pay the price for that knowledge, but, having paid, let us use what we learned. The only real answer will be given by time and testing. We are really in the midst of shaping the right kind of structure or machinery, and we must remember that no machinery, no matter how cunningly it may be devised, will work by itself.

People Must Act

The armaments, the ships, the planes, the guided missiles, the materials and supplies, the inventive genius, the engineering skill, and the raw manpower must all come from the people. Human beings, singly or organized into industry units, are the only ones who can bring any such plan to life and endow it with meaning. And ordinary people just don't live their lives in terms of carefully phased planning.

We civilians must do our part. Industry must continue to study its requirements for stand-by plant and machine-tool programs. We must be willing to serve, and serve faithfully and intelligently, on the many boards and advisory groups which are necessary. We must continue to survey our resources, our manpower, our products, and our adaptabilities with possible conversion in mind. We must maintain permanent liaison with the appropriate Government agencies.

We must continue to criticize any mobilization program as it develops. We must help through participation and understanding to maintain the needed sense of balance that will keep us from slipping into any artificial wartime economy, on the one hand, or into an extravagant and dangerous complacency on the other.

Solution Possible

I should also like to repeat my closing words of four years ago. Participation and understanding are our greatest safeguards. They will wipe out forever the fatal type of M-Day planning which belongs to the past, when we counted the weapons and the horses and made up lists. They will wipe out the dangerous peaks and valleys of improvisation in an emergency. They will keep such programs as we have been discussing the personal responsibility of every citizen, which is as it must be.

With the aid of a little faith, and a lot of God's help, these things may keep us from having to go to war at all. This is our real road to peace.

Control of the Sea

The Core of Naval Power Is the Carrier Task Force

U. S. Navy photo

by Adm. W. M. Fechteler

MANY months ago, my good friend and your late distinguished president extended the invitation to address you. It was a signal honor to accept. Yet now that the occasion is at hand it is accompanied for me with a distinct feeling of sadness in the fact that Colonel Walsh is not with us.

I know how, under the able guidance of James Lawrence Walsh, this Association which he helped to organize in 1919 has grown to its present state. I know we all miss Colonel Walsh's purposeful energy in his efforts to keep our country strong for the enduring peace of all the world.

True Measures of Power

Your Association represents a large part of America's true strength in our world today. The capacity to produce in quantity and the skill to produce in high quality are those true measures of power that set us foremost at about the middle of this remarkable century.

This is an address delivered by Adm. W. M. Fechteler, Chief of Naval Operations, who was guest of honor at the Thirty-fourth Annual Meeting of the American Ordnance Association held at the Waldorf-Astoria Hotel, New York City, December 3, 1952. The meeting was held in tribute to the United States Navy under the auspices of the New York Post of the Association.

That capacity and skill are well known. They have been publicly saluted by the leader of the only nation that plans our downfall.

In the final analysis, victory in war is brought about by the application of intolerable pressures on the peoples of enemy nations. It is the destruction of the enemy's will to continue to resist. The end result is sometimes achieved by physical occupation of enemy territory and the taking over of enemy institutions and government.

Can this happen to us? If so, how could it come to pass that our country could be occupied and our people governed by an enemy?

The history of less than a hundred years is useful to us. French territory has been occupied three times by enemy power since 1870. England, on the other hand, has not been successfully invaded by an occupying force for nearly nine centuries. England, in that period, has at least three times destroyed or frustrated major attempts at invasion.

English Victories

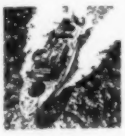
These attempts on England came from the sea. The Spanish Armada was driven off by Drake and destroyed by storm. After Trafalgar, Napoleon did not dare to cross the sea for there were English ships of war between him and English shores.

Finally, in our time, the threat from the sea was poised by Hitler. It was not attempted by the conqueror of Western Europe. The English Channel was still controlled by an English fleet.

Even though German airpower pounded English cities and the countryside at will, Hitler still could not get across to achieve ultimate victory without crossing the sea.

It was Sir Walter Raleigh who declared that "whosoever commands the sea, commands the trade; whosoever commands the trade of the world, commands the riches of the world, and consequently the world itself."

I do not advert to Sir Walter as authority for this Nation to seek command of anything more than our security or freedom from the fear of invasion. The thousands of miles of ocean still constitute for us a formidable barrier or a broad highway depending on how we are forced to regard it. As long as we can come and go on the sea as we need to; as long as we can keep our enemy from doing so when necessary—then can we be secure in our land and at peace with our neighbors.



This Nation's control of the sea is, at present, so absolute that it is taken for granted. It would be a genuine surprise, attended with dismay, if we found ourselves unable to come and go by sea. This casual acceptance gives us a false sense of security.

Erroneous Belief

There is a popular but erroneous belief that if there is little or no opposing naval force then this Nation's Navy can be safely reduced to the opposing minimum. With no fleet to oppose us then all we need is a transport or naval escort force—or so runs the argument. This reasoning sounds simple and economical. Let us apply it to the facts of life of the past thirty months.

In June 1950, the hostilities in Korea commenced. The Navy was at its lowest strength since V-J Day, as were the rest of our armed forces. The first orders issued after the North Korean aggression against the Republic of Korea called on the Navy and the Air Force to act. It soon became apparent that available ground forces would have to be committed to slow the North Korean advance.

Two and one half years of fighting have passed. The combat has been as savage and bitter as any our forces have encountered in any war. We have control of the seas about Korea. We have almost complete control of the air. The war is not won. There is a stalemate.

In the early days of the conflict our naval forces were barely adequate for the tasks to come. But if the Navy had been no more than a transport force, there would have been no amphibious landing at Inchon, the maneuver that broke the back of North Korean aggression. If our naval forces had been ships for transport, supply, and possibly anti-submarine work, the withdrawal of our forces at Hungnam would have been another Dunkerque. Some of the troops might have been saved. Their weapons would be in enemy hands.

Serious Consequence

Assume that we should have had no aircraft carriers. The consequence would be that there would have been a third less of combat aircraft sorties flown in Korea. I have yet to hear any commander complain that we have too much air power in Korea.

The principal weapon the modern Navy uses to keep the sea lanes open is the carrier-based plane. It is no duplication of military effort for the Navy to use aircraft. If such were the case a strong but equally false contention could be made for other weapons.

The same argument could be applied to ordnance. The large-caliber gun is a piece of artillery. Should it belong to that branch of the service that has the word "artillery" in its title? If the argument were sound, Congress would never have appropriated money to arm our ships with guns above a certain caliber.

The airplane is simply a means of delivering a weapon on the target. Like the gun, it puts an explosive charge on something the enemy can use to damage you.

Many Weapons Used

The Navy uses all sorts of weapons. The mine and torpedo are for use under water; the gun, rocket, guided missile, and bombs of all sizes are used on the surface and in the air.

The purpose of the Navy is simply to move a lot of power over the surface of the earth to the place where needed in order that we may be able to come and go on the sea.

Depend on the Sea

Today the United States depends on the sea to receive the multitude of raw materials we need. Our dependence is so great that enemy action against our shipping could reduce or stop the flow of many key materials.

No one armed service and no one weapon in any single service will serve all purposes of our security.

This country needs a strong Air Force, but it needs a strong Army and Navy, too. The Navy needs its aircraft just as the Nation needs a reliable flow of many raw materials from overseas.

The core of naval power is the carrier task force. Without carriers a Navy can only operate in areas which are beyond the range of enemy aircraft. Without carriers our ships cannot cross the sea safely.

Without carriers, we will not be able to establish or maintain air bases overseas. This country needs its air bases overseas. But this country must have its naval power, centered on the carrier task force, capable of projection into decisive areas.

The carrier task force can successfully operate against enemy opposition coming from land-based aircraft. This was done by our fleet off Okinawa in 1945. There, you will recall, we were engaged in seizing a base for operations against Japan. All the support of Army and Marine Corps forces came from the sea-borne forces.

Army troops and Marines were transported on naval vessels. They were safeguarded from surface and submarine attack by naval vessels—large and small. They were protected by carrier aircraft from enemy air opposition.

After the landings on the beaches, the fleet remained for eighty-seven days. The enemy air opposition was intense and sustained. Enemy pilots did their best to deliver their deadly weapons on board our ships personally. These were

the Kamikazes. They were dedicated human beings bent on destroying themselves in attempting to drive off our ships. They represented the ultimate in guided missiles. They failed to drive off the ships. Our ships remained.

Not one of our carriers was sunk in the eighty-seven days it took to secure the base we selected for seizure.

You may hear that atomic weapons render future amphibious operations impossible. The atomic weapons pose an added threat. They do not make future operations at sea or at the shore line impossible.

A ship at sea is a hard target to hit. The best defense against the atomic weapon is dispersion. The atomic weapon is a costly weapon by reason of its relative scarcity compared with conventional explosives. Sea areas in the vicinity of amphibious operations are still wide enough to permit supporting vessels to be so dispersed as to require one atomic weapon to destroy each ship.

What is more, our ships carry means of defending themselves and the troops they support in the critical landing phase. The carrier task force can suppress enemy air forces at the scene of action and within several hundred miles of it.

Navy Will Be Ready

Naval forces will still be able to discharge their functions at sea whatever weapons are produced.

Naval forces will still be required to support our Army and the armies of our allies overseas.

Naval forces, centered about the carrier task force, can supply and support the Air Force at its bases overseas.

These are some of the normal, the routine tasks naval forces perform. They can be performed without extensive depots or bases on foreign soil. Our modern Navy supports itself at sea. Our Sixth Fleet in the Mediterranean has been doing just that for the past six years.

The Navy's floating sea supply system is not fixed. To be attacked, it must be found. If found, it can dissolve itself by dispersion until the threat has passed over. It can then be assembled elsewhere.

That mobility, that flexibility, that persistence and continuity of effort is the true sea power. It is no mysterious force.

In this ability to project our power across the ocean we are supreme today. It is our one greatest military strength. We use it for but one purpose—to maintain peace.

This ability, this capacity will not remain fixed simply because we have supremacy now. Ships deteriorate. Aircraft as well as ships become obsolescent. To preserve our strength we need to replace them at a moderate rate now.

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The orderly program for maintaining a first-class, first-rate Navy is my primary concern as Chief of Naval Operations.

The economic burden of security is too great for any responsible military leader in our Nation to advocate any more than that required to maintain peace and provide against disaster.

Demands for Economy

There were strong and persuasive demands for economy from 1946 onward. We disarmed with joyful abandon and relief. It was understandable. In the postwar period, responsible military opinion called for balanced forces. But a siren's song gave us hope. The prevailing hope was that nobody wanted war and that if he did, well, the atom bomb was ours alone.

We are ever anxious and willing to try anything to achieve peace. Any one who could promise a quick, cheap, and easy means of getting back to a peaceful state of affairs could capture our attention. We wanted security and we wanted prompt delivery. If there was an all-purpose remedy, we would buy that, too.

The new prophets promised serenity with security. It was unpopular to question its attainment. The doctrine was perfection, the creed harmonious, and detractors therefrom belonged to the ages past.

"Little War" Overlooked

Somehow or other we overlooked the "little war," as it is sometimes loosely called. It became an obsession with us to cure only the big things. We overlooked the flea bites that sometimes plague us. Finding a flea on an elephant's back, we are likely to become so intent on killing the flea that we forget about the elephant. No matter how desirable it might be to kill the flea, it would be most unwise to shoot him with an elephant gun.

Do not misunderstand me. There are times when you need not only an elephant *but* the gun, too, no matter which party is in power!

Let me expand upon my own job as it relates to our defense. Within the scope of naval function there is a complex diversity of duties. The readiness to perform these duties is the true measure of a Navy's effectiveness. We cannot wait until after the need for action arises before determining what a Navy will need.

Our real security is latent. It lies in our industrial capacity. You who manage a part of the complex organization comprising American strength know what it would mean if we should be forced to fight in our own land against an invading enemy.

Disruptions and disturbances caused by an enemy invasion would be a sure consequence to our loss of control of the sea.

At present, our advantage on the sea is a safeguard. We must not let it lapse.

Not only this Nation, but all the free world counts on American naval power to insure Freedom's use of the sea.

The Goal of Ordnance Research

Better Weapons with Greater Firepower and Mobility

by

Maj. Gen. E. L. Ford

Chief of Ordnance, United States Army

"The time has come when the research and development of ideas and techniques is almost as important to us as the research and development of weapons and matériel"

THE recent unveiling of our new 280-mm. artillery piece—which can fire an atomic shell in addition to other conventional types of ammunition—was an occasion of considerable significance in many ways. Offering, as it does, the most potent combination of firepower and mobility ever contained in a single weapon, it represents an outstanding advance in Ordnance weapons.

Future Uncertain

With the ever-changing requirements of the battlefield and the methods of waging war, influenced as they are by the rapid and revolutionary advances in science and modern technology, we cannot accurately predict what the future may hold.

The possibility of new scientific discoveries or new applications of known scientific principles that will revolutionize the techniques or doctrines of warfare is always imminent.

There is certainly some possibility—remote though it seems—that the use of the atomic bomb and guided missiles may so change the character of future warfare that the lines of the battlefield may become too fluid, or the forces of an enemy in an attack may be so dispersed, that few worth-while targets within the range of the 280-mm. gun will ever be presented.

Nevertheless, our experience in World War II in Korea has clearly shown that ultimate victory in war is not possible without armed forces moving on land to take possession and control.

It is therefore fundamental that we continue to do everything in our power to provide the kind of tools needed by troops on land to accomplish their unalterable mission.

In support of our ground forces who are destined to play the decisive rôle, we always strive to give them the best ordnance it is possible to produce. In this effort we have always tried to keep ahead of the game through a vigorous program of research and development.

Now I have found among many people a strong tendency to think of research and development in romantic terms. Some like to think of research as a means by which mysterious secret weapons are pulled out of a hat.

While it is true that we do strive to make advances of a whole new order which will contribute decisively to our success in battle, nevertheless I must dispel any illusions you may have that our approach to research and development is on anything but a humble and practical level.

A Long Process

Back of every significant achievement in Ordnance there is the story of a long and tedious process of trial and error—of building, testing, and modifying—in an effort to determine whether a new item of equipment or a new weapon will successfully meet the established need. And during this long and tedious process we are always governed by the dominant consideration as to whether the item we come up with can be produced in sufficient quantity—and economically.

If you were to visit the offices of our Research and Development Division in Washington you would see prominently displayed there an enumeration of our four cardinal principles or design objectives. These are (1) effectiveness, (2) ruggedness, (3) simplicity, and (4) economy.

The Acid Test

Though the techniques of warfare may change, as they have changed over the years, the effectiveness of those techniques is determined by natural laws as unchangeable as the law of gravity. Since the aim in combat has always been to hit your opponent with a decisive blow, and to strike that blow at the proper strategic moment, the acid test of effectiveness in weapons is their capability of accurate firepower and their mobility.

Our aim in Ordnance research and development is, then—as I see it—to increase the effectiveness of our weapons through greater firepower and greater mobility, to make them rugged so they will last, to keep them simple so they can be mass-produced and easily maintained, and to produce them at the least cost in terms of materials and labor in order that we may conserve our resources.

That we have managed to keep ahead of the game is well illustrated in the case of the 280-mm. gun.

The design of a heavy field-artillery weapon which would overcome certain deficiencies encountered in World War II weapons was initiated by the Chief of Army Ordnance in November 1944. This was in accordance with our long-established procedure of evaluation and reëvaluation of the effectiveness of the weapons which we build.

A decision as to desired military characteristics was reached after feasibility studies of several months, and this weapon was far advanced in the development stage when the new requirement for a design that would ac-

commodate an atomic shell was introduced.

That we were advanced in our thinking is indicated by the fact that not too many changes in our current design were needed to adapt it to the new requirement.

The first complete assembly of the 280-mm. gun with atomic capabilities was ready for testing in the spring of 1951. Had our research and development program not been vigorous and progressive, such an artillery piece would still be some vague future possibility.

Success Today

But instead of something for the future, we have succeeded in producing —today—a good, versatile, all-purpose heavy artillery piece that is considerably superior to anything yet offered to our troops in the way of heavy artillery. As to its atomic capabilities, it is only the beginning of such adaptations to provide our troops with tactical weapons for their employment on the battlefield.

Now this process of evaluation and reëvaluation, of experimentation and testing, and of long-range planning that made possible the production of the 280-mm. gun far ahead of schedule is a procedure that is followed with regard to every item of ordnance.

That is as it must be. It is a method of operating procedure that has proved its worth many times over.

In this age of talk about guided missiles, space ships, and rocket trips to the moon, we know that to the doughboy on the fighting front there are still occasions when there is no substitute among his individual weapons for such an item as a reliable and effective hand grenade.

Grenades and A-Weapons

The advantages of an improved hand grenade are not as spectacular as an atomic cannon, and their appeal to the popular fancy is considerably less, but to the individual fighting man they can mean the difference between life and death.

Therefore, while we are earnestly exploring the possibilities of the applications of atomic energy and the use of guided missiles, we are applying the same conscientious effort to everything else that will give our fighting men the mechanical advantage they need in the close-range fighting of the battlefield.

Recent Developments

It was in conformity with such a program as this that we developed the carbine to replace the pistol; the new light rifle, yet to be adopted, with its capability of automatic fire; the recoilless rifles which in effect are pieces of portable artillery; and, in the field of materials, the utilization of such metals as titanium, by which we may reduce the infantryman's load.

While we have paid close attention to the needs of the infantrymen, we have been equally conscientious in our support of the men who support the infantry with tanks and armored weapons and a complete range of field artillery.

For example, our new antiaircraft gun, known familiarly as the Skysweeper, which will soon be in the hands of troops, is one of the finest guns of its type in existence. Designed for use against planes flying at low and medium altitudes, it is radar-controlled and can fire at a high rate against high-speed targets under any conditions of weather or darkness. Since the Skysweeper fires shells with proximity fuzes which will explode if they come close to the target, a direct hit is not necessary to do great damage.

For aircraft flying at high altitudes and at greater distances we have guided missiles coming along that are capable of the kind of performance we would have thought impossible a few short years ago.

One other important area in which we have concentrated much research and development effort is in the standardization of vehicles and the development of interchangeability of spare parts.

A Few Examples

These are only a few examples of the kind of thing we are doing today in Ordnance research and development. And, as you can plainly see, any results that we have obtained are not as a consequence of overnight discoveries but are the logical developments in a long and evolutionary process.

But there is one important facet of our research and development that I would especially like to point out.

As the complexity of modern warfare increases it becomes abundantly clear that our future welfare depends almost as heavily upon the basic sciences as upon the applied sciences. The time has come when the research and development of ideas and techniques is almost as important to us as the research and development of weapons and matériel.

Office Established

Recognition of this fact has already been taken by us through our establishment of the Office of Ordnance Research on the campus of Duke University at Durham, N. C., in June 1951. This office is set up to manage and coordinate a basic research program on a national scale and is giving its attention to basic research projects in all the fields of science in which Ordnance could be considered to have a legitimate interest.

Approximately 200 such contracts have been let up to the present time to various educational and nonprofit research organizations located throughout the country. No startling overnight discoveries are expected to result from these, but we hope to increase our reservoir of scientific knowledge in a practical way that will help us to do an increasingly better job in the years to come.

Basic Research Stage

No one knows quite where this will lead us, but let me present for your consideration the idea that World War III, if such a war should come, might well be now in the basic research stage.

In any event we are preparing to give increased recognition to a third member on our Industry-Ordnance Team—the scientist. He has already become more important to both industry and Ordnance than is generally realized.

406,000 passengers

The Pacific Airlift

Biggest Job of the Military Air Transport Service

by

Lieut. Gen. Joseph Smith

Commanding General, Military Air Transport Service

MATS maintains a worldwide system of air-route facilities and provides other technical services essential to the Air Force

THE biggest single job of the Military Air Transport Service (MATS) today is the Pacific Airlift in support of military operations in Korea. This is a 2-way airlift in which all aircraft carry maximum loads in both directions. From the U.S. West Coast, personnel and critical cargo and mail are airlifted to Japan and the Pacific islands. Passengers from all the services, but primarily the wounded and the sick, are flown to the zone of interior on return flights.

Carry War Supplies

Outward bound for the Far East we carry the sinews of war: men, matériel, equipment, and medical supplies, including that most vitally important shipment, whole blood and plasma. Since the beginning of the Korean conflict, MATS has transported to Japan from the blood-processing laboratory at Travis Air Force Base, Calif., 232,000 pints of whole blood.

Homeward bound we perform the vital military mission of medical air evacuation. Today, no soldier, sailor, or airman wounded in Korea is more than sixty hours away from a hospital in the U.S.—usually the hospital nearest his home or in some cases the one where he will receive the specialized care he requires.

119,000 Tons Lifted

Since the start of the Korean conflict on June 25, 1950, through September 1952, MATS 4-engined transports, together with aircraft and aircrews supplied under contract by U.S., Belgian, and Canadian civil airlines, and a squadron of Royal Canadian Air Force transports, have carried on the Pacific Airlift, 52,000 tons of cargo, 21,000 tons of mail, and 406,000 passengers of whom about 51,000 were medical patients. The total tonnage of passengers, cargo and mail—everything transported by the Pacific Airlift—was about 119,000 through September 1952.

To show how large the Pacific lift bulks in our plans, consider that in a single typical month—July 1952—MATS three divisions, Pacific, Continental, and Atlantic, carried about 6,000 tons of cargo and 50,000 passengers and patients. Of this total almost one half of the cargo and passengers and nearly all of the medical patients were carried by the Pacific Division on the airlift to and from Japan.

MATS is the first example in military history of a permanent "integrated" command: it is composed of both Air Force and Navy units. Primarily, the MATS global air-route command exists to provide scheduled air transport and technical services throughout the world in support of America's entire military establishment. MATS currently operates about one thousand aircraft of twenty-five different types in the transport divisions and technical services.

In this global air effort, MATS maintains a worldwide system of air-route facilities and provides other technical services essential to USAF operations. These vital technical services are: airways and air communications, air weather, air rescue, air resupply and communications, flight service, and the air photographic and charting service.

The fact that each service has its own unique requirements accounts for many different types of aircraft in MATS. However, transports naturally dominate the fleet.

Workhorse of the Fleet

The workhorse of the MATS 4-engined transport fleet is that old reliable war-tested Douglas C-54 Skymaster. But we have phased into our operations the new long-range 4-engined Boeing C-97 Stratofreighter and the Douglas C-124 Globemaster II. By operating these newer and larger transport aircraft we are able to produce considerably more airlift per plane, per air crew, and per airplane-hour.

In addition, one naval transport squadron, VR8 at Moffett Field, Calif., is being equipped with R6D's, the Navy version of the commercial Douglas DC-6; while certain of our USAF units are getting the C-118, the Air Force version of the same aircraft. An aircraft that fills one of our specialized needs is the Grumman SA-16 Albatross used by Air Rescue and Air Resupply and Communications Services.

Other Transports

The rest of the MATS fleet consists primarily of other transport types, plus a heritage of Boeing B-29 Superfortresses from World War II converted for use as rescue and weather-observation planes, and those dramatic Sikorsky H-5 and H-19 helicopters.

MATS Pacific Division operations were thrown into high gear when the Korean Communists invaded South Korea more than two years ago. Japan on the fateful day of June 25, 1950, was only another whistle stop on MATS global air routes—which now total about 115,000 miles.

Our aircraft delivered about seventy tons of cargo monthly, chiefly to familiarize aircrews with flying conditions in the Far East and operationally to provide airlift to the Far East theater. MATS therefore started its airlift to Japan practically from scratch, gradually building up the numbers of aircraft from a handful to well over a hundred.

Air Crews Trained

During peacetime, MATS is like all other military units, basically a training organization. It flies to train air crews in the different conditions they will encounter on routes that circle the globe. The airlift generated through these training flights actually is an outgrowth and a dividend on the training. The generated airlift thus is profitably employed in carrying high-priority cargo and passengers for the Army, the Navy, and the Air Force.

Due to the types of aircraft in MATS —such large cargo and passenger carriers as the Boeing C-97 Stratofreighter, the Douglas C-74 Globemaster I, the Douglas C-124 Globemaster II, and C-54 Skymaster—it is necessary that all aircrew members be specially trained in their safe operation.

At West Palm Beach, Fla., MATS Continental Division gives advance training in our standardized operational procedures to MATS aircraft commanders, pilots, copilots, engineers, and loadmasters. Part of this training, beginning in December 1952, will be done on Curtiss-Wright C-97 flight simulators.

The transport school at West Palm Beach probably will be one of the most unique, modern, and the finest of its kind in the world. The training given there inevitably will result in the most efficient and the safest operational techniques for each type of aircraft, becoming standard practice throughout the MATS global system.

Naturally, MATS operations are spread very thin over a wide area—one thousand airplanes, with less than half of them 4-engined transports—are pretty widely spaced around the world. In any emergency, when a really sizable airlift is called for by the armed services, the necessary planes have to be brought in from all over the globe. In addition, MATS has to call upon the civil airlines for more aircraft and aircrews.

66 Planes Operating

By the end of August, sixty-six 4-engined civil airline planes were operating across the Pacific. These were Douglas DC-4 Skymasters, Boeing B-377 Stratocruisers (equivalent to the military C-97), and Douglas DC-6 Liftmasters.

Meanwhile the Royal Canadian Air Force had contributed one squadron of six North Stars, the Canadian-built version of the C-54 powered by in-line engines. Canadian Pacific Airlines sent three more, and Sabena Belgian Airlines sent three DC-4's. The U.S. Air Force transferred to MATS two Troop Carrier Groups with seventy-five C-54's. These units were later turned over to the Far East Air Forces for employment in the Korean Airlift from Japan to Korea by FEAF's Combat Cargo Command.

Three Routes Employed

Three Pacific air routes are operated from the West Coast to Haneda airbase near Tokyo. By September 1950, a full one hundred aircraft often were airborne over the Pacific at the same time, flying westward with troops and supplies, flying back with sick and wounded. There have been more than one hundred arrivals and departures from Haneda in a single day.

Wounded Flown Back

On the return trip, many of the cargo aircraft are transformed into hospital planes by rigging litters in tiers of three to five, according to the type of plane. The sick and wounded of the United Nations armed forces are flown to hospitals in the United States. In addition, rotation personnel, reparable parts, and other cargo are returned to the U.S., thus utilizing the full capacity of inbound lift.

While air evacuation of the wounded

Below, a large group of military personnel board a MATS transport for the 8,000-mile overwater flight to Japan.
(Defense photo)

is not new, it was not the primary means of transport until the war in Korea. Patients have been flown home at an average rate of 320 a day. In one record day MATS airlifted 448.

95 Per Cent by Air

Maj. Gen. H. G. Armstrong, Surgeon General of the United States Air Force, reported that ninety-five per cent of all evacuations of wounded from Korea have been by air. Air evacuation aids morale, as every soldier, sailor, or airman in the battle area knows that if he is wounded and if evacuation is necessary he is less than three days' flying time away from a hospital in the United States.

Directly supporting both domestic and overseas transport operations are the MATS services which bring a large measure of safety to flying—the technical services which provide communications, weather information, and the rescue of downed airmen and aircraft in distress.

MATS Airways and Air Communications Service (AACS) provides the communications and navigational facilities necessary not only for MATS planes on global air routes but also for all Air Force operations.

MATS Air Weather Service's 2143rd Air Weather Wing in Tokyo, Japan, exercises command control over all Air Weather Service units in the Pacific and the Far East and also operates the Tokyo Weather Central. There are weather squadrons based in Okinawa, Seoul, Korea, Guam, and Hawaii together with eighteen weather stations on the main islands of Japan.

From bases in the Arctic "weather factory" to areas of tropical hurricanes, Air Weather Service airmen and officers take off daily in WB-29's—converted World War II bombers—and fly weather tracks to observe the weather and report to the Weather Central in Washington.

Two Tracks Daily

From Guam, the 54th Strategic Reconnaissance Squadron flies two daily weather tracks. These tracks carry interesting names: "Vulture Kilo" flies to the northwest, and "Vulture India" flies to the southeast.

From Japan, the 56th Reconnaissance Squadron daily flies its Boeing WB-29 converted Superforts on two weather tracks that cover vast portions of the Pacific Ocean. One of these, "Buzzard Kilo," flies over the Sea of Japan to Korea, than across Korea to the Yellow Sea and returns to Japan by way of the East China Sea. The other track, "Buzzard Delta," flies north and skirts the coast of Siberia, moves to the western tip of the Aleutians, and returns to Japan.

Crossing Korea, the flying weather stations go serenely on their way, while

air battles between United Nations Air Forces and Communist MIG-15 jet fighters may rage in the area near them.

Their flights, of course, could not be possible without UN Command control of the air over Korea.

In the AWS job of collecting weather data for all of the United Nations Command—Army, Navy, and Air Force—the 56th Strategic Reconniassance Squadron has not missed a single mission since beginning its operations from Japan in March 1950.

"Typhoon Hunters"

Both the 54th and the 56th Strategic Reconnaissance Squadrons fly into the centers of typhoons—the Pacific equivalents of the Atlantic hurricane. The purpose of these dangerous flights is to collect weather data in order to forecast the force and direction of these violent storms.

These data make it possible to predict the typhoon's movements and velocity, to warn ships at sea, to alert inhabited areas across which the storm may sweep, and to provide time for the evacuation of aircraft from bases that may lie in the storm's path.

From the North Pole, from the Arctic, from tropical islands, from all parts of the world during every hour of the twenty-four, weather reports flow into Air Weather Central in Washington. There they are analyzed and redistributed to units around the world to present a complete picture of weather over much of the globe.

It's still true that nobody can do anything about changing the weather. But at least we know about it, well in advance in most instances, so precautions can be taken.

Air Rescue Service

MATS Air Rescue Service (ARS) provides worldwide search and rescue service primarily to the U.S. Air Force but is available, as every one knows, for all emergencies—civil or military. ARS went into action in Korea soon after the start of hostilities. Since then hardly a day has passed that has not witnessed heroic rescues.

From early July 1950, through September 30, 1952, MATSmen of the 3rd Air Rescue Squadron in Korea have saved more than 7,000 soldiers and air crew members from isolated front-line positions. Of those more than 900 were snatched from behind enemy lines, often in the face of enemy ground fire.

Again, the UN Command's control of the air over Korea has made much of this possible.

Other dramatic rescues are those performed by ARS helicopters, which have picked up United Nations military personnel from behind enemy lines. Despite hostile machine-gun and rifle fire, they have snatched downed fliers from under the noses of Communist troops. One of the helicopters came back from a dangerous rescue mission with five bullet holes in one rotor blade. Many others have been hit.

For its magnificent work in Korea, the 3rd Air Rescue Squadron was awarded the Presidential Unit Citation and is the most decorated squadron in the Far East Air Forces.

Longest Supply Line

In summary, for more than two years MATS has operated in the Pacific area the longest aërial supply line in history —from 5,713 statute miles for the great-circle course via Alaska to the 8,073 statute miles of the mid-Pacific island route. Until the war in Korea comes to an end, MATS will continue to supply airlift, communication and weather facilities, and air rescue service.

MATS is an integral element of United States air power. Its mission in America's global strategy is a vital one.

Army photo

A portion of the 25,000 vehicles now in storage at Letterkenny Ordnance Depot.

Ordnance Field Service

Depot System Successfully Controls Distribution of Military Matériel

By Mark S. Watson

THE admirable performance of American forces in Korea and the large contributing responsibility which the Ordnance establishment has successfully discharged in the theater of operations are familiar to American readers. So are the earlier stages of day-by-day activity within the Ordnance Corps—the research and development in weapons and ammunition and equipment, and the vast production work.

Aroused Admiration

These beginnings and the battlefield endings could hardly fail to arouse attention and warrant the admiration they have both deserved. Yet surprisingly little attention has been fixed on the less spectacular operations of the Corps, which lie between the beginnings and the endings, and which help to make possible the high achievements of our combat forces in the rugged Korean theater.

Work of Field Service

Those middle-ground activities, as far as the Ordnance Corps is concerned, are the work of the Field Service Division, of which Brig. Gen. John H. Hinrichs is chief.

They are not small activities, certainly, for they call for the service of 85,000 military and civilian personnel, roughly half the total of the Ordnance Corps. And all the work which is done for the support of our troops in the Far East, in Germany, and in the lesser overseas theaters combined, approximates in amount what must be done on a day-by-day basis for troops in the Zone of the Interior. It is an immense total.

The Field Service Division of Ordnance is beyond all doubt the largest distribution system in the world, whether one measures by the amount of goods, or their value, or their variety, or their points of distribution, or, one dares say, the urgency or the unpredictable nature of the missions included in the day's routine.

Comparison Made

Comparison is sometimes made with one or another of the great mail-order houses which distribute a lot of items to a lot of people. But the differences are pretty wide. For the number of Ordnance items, including the parts, is very much greater than that in the bulky mail-order catalog, and their total is enormously greater in weight, or size, or value.

The mail-order people undoubtedly have their troubles, but they at least have a stable market. They can select the market they wish to reach by scientific analysis and then go for the profitable regions and ignore the others. They can select their products on the same basis and even their brands of products.

Can Adjust Production

They can adjust their production to meet demands, and can even control the demand by pricing up or down. They can pack shipments to guard against conditions encountered in a specific delivery at a certain time, rather than being compelled to use safeguards against all kinds of temperature or humidity at any time in the future and against all kinds of rough handling. They can drop a market area or a line of goods altogether if it is found unprofitable, and if they are unable to

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supply some demand or other nothing happens except that the company makes a little less money that year.

"What a happy life!" the Ordnance Field Service man ejaculates. His customers are more exacting. *He* cannot drop a line of goods just because it provides too little profit or too much work. He cannot exercise any control whatever over his market; nor do his friends, for the Field Service's market in an active theater of operations is determined, instead, by the enemy.

He cannot know when such a market will develop, or where, or in what items, or in what quantities, or with what requirements for spare-parts replacements—all of which makes advance estimates of a situation just a mite difficult, as a cautious Vermont farmer expresses such things.

Serious Consequences

And whereas the mail-order house's failure to have the right goods available on demand means only a reduction of profit, the Ordnanceman's failure would mean a loss of life for Americans dependent on Field Service for its arms; in his case failure or delay could therefore mean the loss of a vital campaign or, at best, a great deal of expense in life and effort and equipment to regain lost territory or to balance that loss elsewhere.

A great deal can be, and is, learned from mail-order distributing techniques (precisely as much is learned from other experts in industry and commerce). But the interesting thing is that, in turn, industrialists who serve on advisory committees for Ordnance frequently remark that they have learned *from* Ordnance too; usually these counterlessons are in techniques at which (by reason of the stern exactions of wartime) the military personnel develops a good deal of inventiveness under pressure.

A recent example is in the art of packing trailers on flatcars, where the Mount Rainier Ordnance Depot proved able to pack twice as many items as the industrial advisers had seen packed before—primarily because scant ship's space to Korea had called for special ingenuity in packing. The aid which industry can give to Ordnance techniques is enormous, but it is pleasant to find that now and then the beneficiary can return the favor.

Give and Take

Certainly there should be a great deal of give and take as far as Field Service is concerned because its fundamental job is—like that of any distributor—simply that of taking the goods from the production line and giving them to the "customer." To that end, therefore, Field Service employs depots to hold the goods ready for delivery, maintains the goods in proper condition, and repairs them or remakes them as needed.

And, in reverse, Field Service has the job of gathering up goods when their work seems to be done, and restoring them to usable condition or selling them or scrapping them or destroying them altogether.

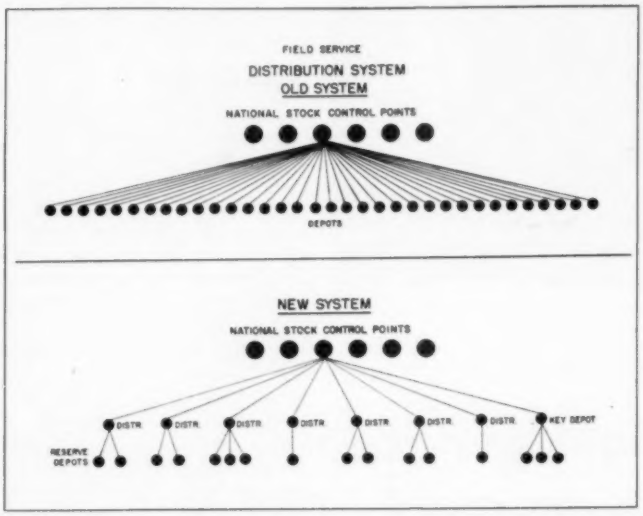


Diagram of the old and new distribution systems of the Ordnance Field Service.

Large-Scale Operation

To do this calls for planning and management and operation on a scale and in a manner of which the public knows very little, indeed, and of which it is safe to say too little is known even by Ordnance personnel engaged either in the "beginning" realms referred to—of research and development and production—or in the "ending" realm of battlefield use.

In discussing the intervening realm of the Field Service Division this article will concern itself only with the first part—service *for* the troops. The later part—service *with* the troops—calls for separate treatment on a later occasion.

Impressive as service *with* the troops is, it is difficult to understand fully unless one is already well informed about the service *for* the troops which is performed by Field Service in this country by its remarkable integration of distribution and key and back-up depots, and of the stock- and maintenance-control points needed to control with precision the flow of supply to the ports.

Result of Experiment

It is no hasty contrivance, but rather the result of many years of experiment and redesign and reëxperiment in continuous sequence. Hence that process goes on today. One of its momentous forward leaps has taken place in the past two years through a depot realignment plan of which surprisingly little is known outside the service itself.

Another, if less startling, improvement seems to be under way now in the Management Control Intelligence

Project which was initiated last spring and which already, in its initial test area, begins to justify the hopes advanced for it.

Concerned with Methods

Both enterprises are concerned with methods. At this stage that is where progress must be attained, rather than by such revolutions as took place in World War I when transport was changing as radically as weapons from the simpler standards of the nineteenth century and was forcing organizational changes of equal violence. The old-time wagon and harness had been kept in repair by the driver and his passengers with a little ready aid from a handy smith; a good many contemporary weapons could be kept in fair repair by their users.

But experience in France started some large reforms in field maintenance as elsewhere. The postwar Army reorganization under General Pershing as Chief of Staff went far beyond the familiar 1921 changes in the General Staff. In Ordnance itself a Field Service Division emerged, with responsibility for an Ordnance distribution system which prevailed until World War II. Then came 1942, with its radical changes of organization, about which it will be difficult today to get judgments in agreement, so strong were the personal hostilities that were engendered in that feverish period.

Then came another postwar reorganization, soberly and deliberately set up in the hope that it would prove economical and efficient in peacetime yet have within it the powers of orderly expansion to such a size and character as a new war emergency would call for. One never can be sure. In 1917 there was the sardonic tale of a certain lofty chief of bureau in the old State-War-Navy Building who was detected wringing his hands in despair and explaining that "I've spent years organizing my office to perfection, and now this war comes along and knocks it flat."

Some Confidence

He had plenty of spiritual children in early 1942, and we can only hope that some spiritual grandchildren won't show up a few years hence. One can hope it with some confidence, however, for the Korean business has been big enough to provide quite a strain (as some later figures will show), and there has been nothing "knocked flat" —or even shaken. Ordnance has expanded in an orderly manner (as have Quartermaster, Signal Corps, and other branches); the changes have been not in organization, which has proved admirable, but in a few methods, which have proved readily adjustable.

This applies to the several operating divisions of Ordnance (Research and Development, Industrial, Personnel and Training, and Field Service), but this article will concern itself only with the last-named and, as earlier remarked, with that service *for* rather than *with* the troops.

Job of Distribution

The Field Service Division's job, in simplified terms, is to distribute weapons and equipment from the factory (which is the Industrial Division's area) via the depots to the troops. Up to the time of delivery to the troops this is the responsibility of the Chief of Ordnance (assigned, of course, to his Field Service Division); the later responsibility is that of the Army and of its commanders in the various theaters.

It is true that the Chief of Ordnance is responsible for *technical* supervision even in the later stage, but supervision at that stage is only through *technical* channels working down from the Chief of Ordnance; the command proper of Ordnance units in the theater, of course, goes through normal command echelons working down from the Chief of Staff via the Army or theater commander. It is when something goes wrong with matériel or technique that the trouble bounces back to Field Service.

Has Six Branches

Now what is the administrative establishment through which the largest distributing business in the world is conducted? It starts with the chief of the Field Service Division, who is immediately responsible to the Chief of Ordnance, in the same echelon with the Industrial, Research and Development, and Personnel and Training Divisions. The Field Service Division possesses six branches, largely policy-making, which for present purposes need be discussed only briefly as follows:

Operations.—This branch sees to the accomplishment, at depot level, of the policies and practices laid down for the

Brig. Gen. J. H. Hinrichs, right, chief, Field Service Division, and Col. G. F. Powell, head, Planning & Management Office, inspect supplies at Sierra Ordnance Depot. *Army photo*

Field Service Division; it coördinates the work of the three branches next named and provides housekeeping direction.

General Supply.—It supervises the storage and distribution of all ordnance matériel except ammunition, coördinates and supervises all stock-control points and depots (these terms will be explained later), gives technical advice, and disposes of all matériel.

Maintenance.—This branch, too, deals with all ordnance items except ammunition. It is concerned with maintenance in storage, with normal repair, and with complete rebuilding and modification (of great importance just now when much of our surplus matériel is being converted to MDAP use). It issues instructions involving fuels, lubricants, and cleaning and preserving materials.

Ammunition.—This branch combines supply and maintenance functions affecting all ammunition items. Its concern with maximum safety in storage, renovation, transport, and distribution is complete.

Packaging.—It is newly created as a separate branch by reason of the growing efficiency possible in this field where a few cents in care can save many dollars as well as assure sound matériel at critical times. Its work is broken into seven sections for intensive study of the great range of widely differing items.

Requirements.—It works closely with G-4 of the General Staff, computing ordnance needs and procurement requirements.

These branches, to repeat, are largely concerned with policy. The operating structure of the division is another matter and can most readily be grasped if one thinks of it as functioning at three levels, as follows:

Headed by Chief

At the top, of course, is the chief of the Field Service Division. In immediate contact is his planning and programing group.

At the second level are the six national stock-control points (they are split commoditywise—weapons, vehicles, guided missiles, fire control, tools and equipment, cleaning and preserving) and the six national maintenance points (similarly split). Here is, in a sense, the heart of the distribution system as lately modified; here the program directives are translated into specific actions.

Distribution Depots

At the third level are (a) the seven distribution depots (with their twelve "back-up" depots), all carrying a very large assortment of items in common use, and (b) the five key depots (with thirteen "back-up" depots of their own) each of these being stocked with a specific category of items rather than with the full variety of the distribution depots. Here the operation of actual storage and distribution, retail and wholesale, is conducted.

> *"From procurement right through our task of getting supplies into the hands of our troops, we must do our job in the most businesslike way possible. We are carrying on a supply and distribution mission of great magnitude—it is big business—and must be operated with the maximum level of efficiency. . . ."*
>
> —Maj. Gen. E. L. Ford
> *Chief of Army Ordnance*

Each distribution depot is responsible for supplying the troops of the allotted area, and to that particular depot (and nowhere else) the troop commanders make their requests for service. That is why the distribution depot is stocked with all items in common use—so that in most cases the troop commander's needs can be met immediately from available stores, either in the distribution depot itself or in one or another of its own back-up depots at not too great a distance.

But there will be occasions when the requisition for a specific item cannot be fully met by the responsible distribution depot commander from his own shelves or those of his back-ups. In that case the C.O. communicates with the national stock-control point concerned with the category which includes the desired item. The stock-control point, knowing the inventory of all the depots, then levies on the depot which its record shows to have a surplus and has the needed shipment made forthwith—sometimes to the original distribution depot but more often to the requisitioning troop unit itself direct, if that would result in a saving of time and shipping charges.

In the event that there should be on hand in the whole system an insufficient amount of the item desired, the office of the chief, Field Service Division, would get that report and procurement of a new supply from the factory would be put under way by the normal Industrial Division process. But in practice any such likelihood is discernible a long time in advance, and the correction can be thought of as having been initiated long before the rising of the contingency.

How is that assured? By the inventory system patiently built up whereby, thanks to periodic examinations and methodical current entry, each of the distributing depots knows its own possessions precisely, and also those of its back-up depots. But that knowledge with regard to each list of items is shared at each period at the appropriate key depot and cumulatively at the appropriate national stock-control point.

System Flexible

So flexible is the stock-status reporting system that in the event of total destruction of a national stock-control point, the complete worldwide stock position could be reconstructed rapidly at another Ordnance facility to get on with the supply job. This is a part of the basic aim—to establish in peacetime a system marvelously adapted to the requirements of a war that might be more serious to the interior zone than was either World War I or World War II in that there is envisaged the possibility of attack on installations in continental United States.

As far as current operations are concerned, this periodic and complete inventory exchange makes it possible for

the national stock-control point to do most of the reordering and reshipping and leveling off among the several component depots as simple routine, without waiting for requisitions. And, thanks to planning intelligence, much of this can be done with a large foreknowledge of requirements exceeding that of even the most astute manager at the basic depot.

Perhaps "simple routine" is not quite the right expression, for after all there are some 400,000 items, and even if you divide 400,000 item cards into, say, lots of 100, that still means 100 stacks, each containing 4,000 cards—which sounds like something rather complex for hasty filing or search. It would not be possible to make any quick search save for the wizardry of modern machine card punching and identification.

Probable Requirements

The stock-control points learn at the outset all about the items and their performance records. At those points, therefore, can be computed the *probable* requirements not only for assemblies but also for parts to fill those requirements.

The integration of the national maintenance points into the above procedure has long been intended but it has not been quickly achieved, for the very bulk of the system was a deadening influence, so much so that in early 1951 Maj. Gen. E. L. Ford, the Chief of Ordnance, ordered a study of simplification possibilities. In retrospect it was suggestive of the order which General Pershing gave in 1918 to Maj. Gen. James L. Harbord, then commanding a first-class division on the Western Front. It was to reconstitute the American Expeditionary Force's terribly confused supply system so that goods would flow quickly to the front.

System Simplified

General Harbord achieved his own miracle in a matter of weeks, by simplification, and it was his "commodity depot" system which General Ford suggested for restudy by Col. G. F. Powell, of Field Service's Planning and Management Office. What Colonel Powell came up with was a radical simplification of the reporting system. At one clip it called for 8 lines of report instead of 37—a swift drop of 79 per cent.

Developed Outline

The outline of his plan he worked out with Lieut. Col. G. M. Megica, of his office, and many other officers and civilians in the system, under the vigorous encouragement of both General Ford and General Hinrichs. Thus the Depot Realignment Plan, whose implementation began in June 1952, will soon be running smoothly.

It is the sort of swift rearrangement which comes about in war, by necessity. The remarkable thing about this system is that it was planned and executed in peacetime, before the need was irresistible, and without a convulsion of either organization tables or of personnel.

It is part of a system whereby the troop basis can quickly be related to needs; whereby the work is rationally divided among the depots; whereby the depots can know in proper time what must go in and come out; whereby the stock-control points can do their charting in advance. This is quite an achievement, and it was performed without fanfare.

There is another notable addition to the original scheme, which is properly a part of the stock-control system but is separately designated as the Curtis Bay Regulating Office. Its work covers all the movements to and from the depots. The aim is to smooth those movements by advance knowledge of requirements and appropriate programming.

Combines Shipments

It combines shipments into full carloads; issues movement orders with a knowledge that the shipment will be ready at one end and space for its receipt will be ready at the other, thus avoiding idle cars and demurrage charges; diverts shipments and sends them by shorter or more efficient routes (through knowledge of current railroad movements); makes shipments from a near-by branch instead of a main factory where this means saving of money —or of time, which on occasion is more important than money to troops in battle.

Army photo

Special tanks protect vehicles from rust, deterioration, and corrosion for as long as twenty years at the Letterkenny Long Term Storage Tank Farm shown above.

One may mention, too, another extension of what used to be a moderately used power of local purchase. This is habitually done in food purchases by a post Quartermaster, sometimes for reasons of economy, sometimes in quest of fresh vegetables, etc.

It is entirely practicable for Ordnance

as well, if it is apparent that a much-needed spare part can be bought from a local dealer immediately. But at present there is in prospect a long extension of this procedure, with a view not only to quick supply but to avert the stocking up of depots with items which are necessarily carried by civilian dealers everywhere.

Possible Danger

It sounds reasonable at first, but an outside observer can raise the question of whether it involves peril. For wars have a way of coming unexpectedly and creating sudden shortages in civilian supply. And against such a background it is reasonable to ask whether—excepting always purchases of an emergency character—it is not better to count on full stocking and supply by the standard depot system for two prime reasons: First for the maintenance of continuous practice and resultant good habits, and, secondly, for Ordnance's own continued compilation of experience tables which are the surest of all guides to stocking practice at the depots and to basic planning itself.

Rational Revision

A rational revision of familiar depot practice is one which is under current consideration; *viz.*, to limit the stocking of the main "retail" distribution depots to items which are in extremely common use. A recent survey has shown Field Service that something like fifteen per cent of the "active" ordnance items meet eighty-five per cent of the troop demand. Or, looking at the other end, eighty-five per cent of the vast number of items are called for in only fifteen per cent of the troop orders.

This suggests a very great potential economy of operation. Under it, the rarely sought items would be stored only in the key depots, from which they would be obtained by the retail distribution depot with normal celerity. It indicates an economy worth going after, and is an interesting example of persistent restudy of functions by an energetic management.

The foregoing has dealt largely with two main stages of Field Service operation—the "stocking" stage and the "issue" stage—those areas where the depot system functions. There is another stage whose importance is just as great which may be called the "customer-service" stage.

Here come the big problems. Those of supply are concerned with shortages at one point or another in the production and distribution chain; they may call for rationing, or for substitution, or for emergency procurement which includes a lot of rapid footwork and sometimes hard words.

The maintenance problems spring from field reports, usually involving malfunctioning of weapons or equipment, and they call for swift inspection and perhaps spot action. That is, if inspection shows that the malfunctioning is serious enough, immediate suspension orders to all commands can cancel use of an item.

Other Data Shown

Meantime inspection will show whether correction can be made by Field Service units, or by return to industry for change in materials or manufacture, or by laying the problem before Research and Development personnel for basic change in design.

The last category is not so often encountered—in the vast majority of cases Field Service personnel at one echelon or another prove able to meet urgent requirements.

"Withdrawal" Stage

There is one more stage of Field Service activity, which can be called the "withdrawal" stage. Beyond the many items which simply wear out too completely to justify reconstruction there are some which reach obsolescence, possibly because their original purpose no longer exists or, more likely, because research and development have produced something better. The items so classified then are considered, possibly for use by other Government agencies, possibly for adaptation to some form of foreign aid, possibly for disposal as surplus or scrap, to the highest bidder.

There have been times, one may add, when such a "death certificate" has proved a trifle premature, and the Army, belatedly discerning a forgotten need or missing out in its overhopeful planning, has had to resurrect these supposed corpses for rehabilitation and reissue. But that is not to be charged to Field Service, nor is it frequent.

Another Approach

For purpose of further clarification, one can approach this complex operation from another direction. Let us assume that a war plan has been drawn up by the several elements of the Joint Chiefs of Staff and that for its implementation G-3 has set up a troop basis and G-4 the requirements order for supporting such a troop basis. Now the requirements total (as far as Ordnance is concerned) is the sum of two parts: what exists as assets and what remains to be procured.

Aërial view of general supply storage warehouses and combat vehicle rebuild shops at Letterkenny Ordnance Depot. *Army photo*

A report on assets is obtainable from the Ammunition Branch and the General Supply Branch in combination. From each, the Chief of Ordnance can learn (1) what is already in the hands of troops and (2) what is in the depot system (a) either ready for issue—familiarly abbreviated to RFI—or (b) unserviceable but still reparable by the maintenance units, whether through maintenance in storage (MIS) or through rebuilding and renovation, which is a major program.

Army photo

Workers at Letterkenny Depot load jeeps on flatcars for shipment to ports.

Card-Index System

The distribution system's stock control sets out clearly the what and where of all this, primarily from its card-index system, a thing of marvelous ingenuity for whose full development to the Army's benefit industry has given the Field Service Division its most generous aid.

Now by deducting all these assets, properly appraised as to readiness at given times, from the total requirement order, one obviously determines the net procurement required. This report goes to the Industrial Division which thereupon takes over in the manner generally familiar, after a decade of its activity, even to the lay public.

The planning of G-3 and G-4 is ideally aimed at the desirable target of having trained men and proper equipment arrive together at the assembly area. Now and then that aim is achieved, and great is the rejoicing. But it can be achieved only by marvelous teamwork as well as skillful planning, both of which have been present to a surprising degree in these past two years of limited mobilization, with its emphasis on a large and expandable production base rather than on all-out production of matériel, and with personnel training at a pace appropriate to the considered program.

World War II production was inevitably clumsy by reason of its magnitude and the extravagance of equipment use—with practically three issues to the same soldier in many instances—one for early training, one for maneuvers, and a spic-and-span new one for overseas. This procedure, which helped produce a lot of the surplus of postwar times, also tended to make men careless of their equipment, knowing they would get something new later on. Hence it helped to provide Field Service with maintenance problems which are not yet over.

Creates Problem

Incidentally, the present personnel rotation from Korea, necessary and desirable as it is in other respects, gives rise to something of this same problem, for only a first-class soldier, knowing that he is soon to give up his rifle and other equipment on the way to discharge, will turn over his equipment in prime condition. And the new soldier who succeeds him is not often skilled in taking care of it.

Another immense problem in maintenance is occasioned, as might be expected, by the complexity of the new weapons. The fire-control mechanisms of the M38 and the T33 and their counterparts call for very close attention, and it is gratifying to find out how quickly the new program of Field Service maintenance has taken effect. General Hinrichs noted with pride a few weeks ago that, in the course of two months, inspection showed a drop of ailing items from thirty-two per cent to sixteen per cent.

Streamlined Procedure

How? It included a streamlining of requisition procedure, he explained, and this meant a quicker arrival of needed replacement parts. The factories were persuaded to put out more parts in the first instance, and the flow from factory to customer through Field Service was made easier and faster.

But a very large factor was the persistent sending out of skilled operating and maintenance teams to the field units to show them the tricks of the trade, to detect faulty operating practices, and to make correction by demonstration instead of offering long-range advice by circuitous channels.

Another factor is the practice of having one man drive his particular jeep, which means that he takes as good care of it as he does of his own personal equipment.

Training Important

This is more than "book learning"—useful as book learning is. It comes, rather, from great thoroughness of procedure and practice from top to bottom. The larger the force-in-being the more important is the thorough training of the key personnel which has to set standards for imitation by the endless torrent of new and transient personnel. A drive for watchfulness and efficiency is based on the General Supply Distribution Plan already referred to as being now under full headway. Its principles succinctly stated in a memorandum from General Hinrichs are these:

1. Supply the customer with the "right goods in the right amount at the right place and the right time." This is paramount.

2. Keep the system as simple as pos-

sible, for the customer as well as for the operator.

3. Meet requirements for dispersion.

4. Keep the system as inexpensive as possible.

5. Make it flexible, to meet acceleration or curtailment of activity.

6. Separate the wholesale and the retail functions, so that the small customer can get what he wants quickly and easily and the big jobs can be handled without interruption.

7. Have one source of supply for the customer.

8. Keep a limited stock at distribution depots to avert congestion.

9. Do not dissipate stocks of critical items. Use substitutes wherever possible.

10. In a troublesome case, if you can get a ninety per cent solution right away, do so, and then get the ten per cent correction when you can. If you seek perfection at the outset on every transaction, the job may not get done at all.

Conference Held

There was an October conference of Field Service depot commanders at Colorado Springs, largely to examine one phase of Ordnance efficiency efforts—the Management Control Intelligence Project. It aims fundamentally at having the right information in the hands of people who need it.

General Hinrichs had remarked wryly that he found the outlying depots getting a great deal of information they do not need, and missing a great deal that they do need, and his grass-roots conference with the depot chiefs themselves was to get them to ask for what they wanted.

Already it was possible to know a good deal, for Col. H. F. Bigelow, General Hinrich's executive officer, had engaged in his own first-hand inquiry among the several depots.

Also, thanks to a happy inspiration,

Letterkenny Ordnance Depot itself had been since July the center of a pilot project, which by October was already producing solid ideas worthy of further development. An autumn on-the-spot inspection, lasting one week, has been made by a project team from the Office of the Chief of Ordnance, from G-4, from the Office of the Under Secretary of the Army, and from the Office of the Defense Department Controller.

Studies Initiated

Its members conferred with Letterkenny's own middle-management group of seventy civilian and thirty military workers and then embarked on three successive studies. These are evaluations of: (1) the Transport Vehicle Branch of Depot Maintenance,

"Perfection of design and manufacture will do much, but they will fail unless goods reach the ports, and thence the troops, 'in the right amount at the right time and the right place.'"

(2) the Bulk Storage Branch of General Supply Storage, and (3) one aspect of Bulk Storage of Ammunition. In each case there were five steps:

1. Informal discussion with management personnel in order to learn the problems of that group, the sort of added information which would be helpful, and the manner of using that information.

2. Assembly and analysis of the facts so learned.

3. Evaluation of the analysis, with recommendations.

4. Discussion of these recommendations with management personnel.

5. Presentation of recommendations, revised as needed, to the depot management.

Of the three studies, at this writing, No. 1 has reached Stage 4, No. 2 is at Stage 2, and No. 3 is beginning. But enough is known to make sure that there is need for cost accounting at each stage of work, as generally adopted in business. (One can hear an echo of congressional cries for cost-consciousness.)

And it is demonstrated anew, also, that there is need for unending emphasis on an understanding, by civilian and military personnel alike, of each man's responsibility. For that matter, several high-ranking officers from the Pentagon itself admitted ruefully that some of the things they learned at the grass-roots level were things they should have found out long ago.

Letterkenny Ordnance Depot is an excellent spot for its purposes as well as for the pilot study. Remote from population centers and naturally guarded from aërial observation much of the time by its haze, it still is accessible by reason of geography. It has its fair portion of widely varying functions, as follows: ammunition washout, ammunition storage, ammunition demolition, small-arms linking, tire recapping, combat- and transport-vehicle rebuild, engine-accessory repair, armament repair, fire-control and radio repair, general supplies packaging and storage, long-term storage of "canned" vehicles, carloading and shipping.

These functions require large acreage, but the depot is so well prepared for expansion that 2,600 of its 20,575 acres can be rented out seasonally for crop raising. The depot, now under command of Col. Thomas F. Donahue, has 151 miles of road and 58 of railroad, 32 warehouses and 428 buildings of all types apart from its 12 ammo magazines and its 802 ammunition igloos.

There are 23,000 vehicles in storage, or about half the maximum of other days. Military personnel number 40, civilians 6,800.

Key to Success

The Ordnance depot system has long been a key to success of the field command, and always will be. As the familiar saying has it, supplies alone do not win the war but the lack of them can lose it. Perfection of design and manufacture will do much, but they will fail unless the goods reach the ports, and thence the troops, "in the right amount at the right time and the right place." The Field Service Division has that job, whether for a small operation or a great war. Theaters change, weapons change, commands change. To every change Field Service has to be ready to adapt itself when the whistle blows.

Rubber and National Defense

The Product Is of Vital Importance to Army Ordnance

J. E. Trainer

THE rubber industry in America includes some 500 different companies, large and small, which work with one of the most versatile materials known to man. No other material combines all of rubber's properties. You can stretch it and it will snap back. You can bounce it. It can be made into products having such vastly different properties as soft latex pillows and hard golf balls. It can be formed into surgeon's gloves so thin and pliable they don't interfere with the sense of touch or into rigid storage-battery cases. It is waterproof. It does not conduct electricity unless specifically compounded to do so, and it can be made to outwear tough metals while still remaining elastic and flexible.

Widely Used

It is little wonder, therefore, that products of rubber are used by every man, woman, and child, or that without rubber most of the forms of modern transportation could not exist.

The importance of rubber to our national security is emphasized by the fact that it is the only major raw material that has been made the subject of separate legislation. The Rubber Act of

1948, subsequently extended, gave the Government a large measure of control over rubber and the rubber industry.

In order of importance, the first job of the rubber industry as an Ordnance supplier is to provide tires and tubes. Tires are essential for Ordnance vehicles, for aircraft, and for trucks, buses, and automobiles to transport war matériel and war-plant and military personnel.

Mr. Trainer is vice-president of Firestone Tire & Rubber Company and a director of the American Ordnance Association.

But tires are not the whole of the rubber picture. Today, all our combat tanks roll on rubber tracks and rubber bogies. Engines are mounted on rubber. Combat aircraft are equipped with bullet-sealing fuel tanks made of rubber. Other rubber equipment used by the armed forces includes inflatable boats and life preservers; bridge pontons; protective clothing; hoses for transmission of fuel, oxygen, and air, and for fighting fires; footwear; medical supplies; gas masks; high-altitude oxygen masks; fan belts; storage-battery cases; weather balloons; wire insulation; crash pads for tanks; and gaskets for applications ranging from engines to food containers.

Plastic Products

In a field closely related to rubber in many respects, the industry has provided for the armed forces articles of molded plastic, such as gunstocks, helmet liners, and prescription-type shatterproof lenses for eyeglasses.

Based upon mobilization plans as we know them today, it is estimated that forty-three per cent of the rubber industry's output will be required for direct military items in the event of a major war. A further twenty-seven per cent would be required for indirect military items, such as truck tires for transportation within the United States of military supplies and personnel.

The remaining thirty per cent of the industry's capacity would be available for civilian production. And this civilian production, to a large degree, is also essential to the prosecution of a war.

Since World War II we have witnessed a great development of new residential areas—at greater distances from jobs than old established residential areas. Industry, too, has been expanding, and the trend has been toward outlying and smaller communities where many plants depend upon labor drawn from an entire county, or several counties. Such are the changes in pattern of living and working that have been fostered by our becoming a nation on wheels.

However, the scope of the rubber industry as an Ordnance supplier is not limited to rubber products. Many years ago some members of the industry found it desirable to provide their own rims to match their tires. Furthermore, many rubber companies set up machine shops for making tire molds, which require very intricate machining, and for other special production equipment.

Long Experience

Consequently, long before World War II, the industry had organizations experienced in the fabrication and machining of metals. This experience was pressed into service for the manufacture of many items required by the armed forces—most of them by Ordnance.

The list included antiaircraft guns, tank cannon, rockets and rocket launchers, airplane structures and wings, wheel and brake assemblies for aircraft, complete fighter planes, tank turrets, trench mortars, high-pressure oxygen cylinders, belt links for machine-gun cartridges, and hundreds of other items.

Today the rubber industry is engaged in the production of many of these same items. In addition it has taken on new jobs in the metal-fabricating field—jobs that were but dreams during World War II. Among them are jet-engine parts, guided missiles, and the recoilless rifles that let the infantryman carry his own artillery.

The history of the rubber industry has been one of fierce competition. Its chapters include lean years and years of bitter price wars, with survival itself in the balance for many members of the industry.

Production Now Scientific

The rubber tires of today are products of chemistry, engineering, and physics. There was a day when the man who ran the mill for mixing rubber compounds used little but his own judgment as a guide. He mixed his stocks like an old-time cook—a pinch of this, a little more of that—until the batch on the mill looked right. Today, formulas are worked out scientifically, tested, and controlled in production by chemists. Engineers establish tire designs and construction. Research laboratories, with large staffs, constantly seek better compounds and improved compounding materials.

Thus, over the years, the industry has developed an unusual reservoir of management and technical know-how. And, in addition to the output of its plants, it has provided personnel for special armament projects. Several members of the rubber industry operate large Government arsenals for the loading of bombs and shells.

But let's bounce back to the subject of rubber. Recently, the man who was Germany's rubber director during World War II was in my office. As many of you know, Germany developed the type of general-purpose synthetic rubber upon which our country's GR-S was based. She did so largely because of her experience during World War I when inability to get sufficient natural rubber through Allied blockades was a heavy factor contributing to her defeat.

Despite Germany's World War I experience, history repeated itself with respect to rubber, as well as with respect to Germany's defeat. The German rubber bureau was caught unawares by Hitler's decision to invade Poland, and when war in Europe broke out in the fall of 1939 Germany had a natural rubber stock pile of less than 15,000 tons.

After desperate efforts in all the available European markets, Germany added something less than 10,000 tons to this stock pile within a few months after the Polish invasion. Thereafter, through 1943, a total of 74,000 tons were delivered to Germany.

These new supplies came from stocks in captured countries and from Indo-China and Thailand, with the assistance of Japan. Much of it reached Germany with transportation help from Russia during the brief period of alliance between these countries.

So Germany fought the world for five years on natural rubber supplies totaling only 99,000 tons—almost exactly one year's supply at her prewar rate of usage.

Tire Cord

There was something else that Germany forgot or ignored—tire cord. The German supply of cord with high-stretch characteristics

was totally unsuited for use in synthetic-rubber tires, and as a result their tires grew in size and developed cracks at low mileages. One of the lessons we learned early in the war was that high-tenacity rayon cord was essential in the larger tires made with high percentages of synthetic rubber. And we were fortunate in having a rayon industry with sufficient capacity to supply cord requirements for the larger tire sizes.

Germany entered the war with an annual synthetic-rubber capacity of only 26,000 tons and expanded it during the war to 132,000 tons a year. So, if we figure the synthetic at its peak capacity, Germany had available a maximum rubber supply, natural and synthetic combined, of 150,000 tons a year.

Of course, the curbs put upon civil-

ian uses of rubber in Germany were drastic. Tire compounds were degraded so far in rubber content that driving speeds behind front lines were restricted to 17 miles an hour. (And we griped about a 35-mile speed limit!)

Capacity Not Reached

Throughout the war the German rubber industry never operated above seventy-five per cent of capacity. At its peak war output, the industry was set up so that 7 per cent of its production went into tank treads and bogies, 56 per cent into other mechanical goods, and the remaining 37 per cent into tires and tubes.

Of course, no country of vast distances such as ours, with a people who depend upon automobiles instead of bicycles, could approach the German economy in the use of rubber. There may well be, however, lessons we could draw from the Germans in maintenance—in conserving tires, for example. The fact remains that Germany fought World War II on a yearly rubber supply which was equivalent to about two months' total rubber consumption in the United States at the peak of our war effort.

In past years the United States has been dependent upon foreign sources for its rubber supply. Except for a few special-purpose rubbers, our country had no synthetic-rubber industry before Pearl Harbor. Specifically, in December 1941 our country had a synthetic-rubber-producing capacity, in operation or nearing completion of construction, totaling about 12,000 tons a year.

Shortly before Pearl Harbor approval was given for construction by our Government of four plants for the manufacture of general-purpose synthetic rubber, each to have a capacity of 10,000 long tons a year. Compare this total of 40,000 tons of authorized capacity with our consumption of more than 600,000 long tons of crude rubber in the year 1941!

Immediately after Pearl Harbor, increases were authorized to bring the Nation's synthetic capacity to 400,000 tons a year. And when Singapore fell in early 1942 our Government authorized further new synthetic-plant construction to raise our total manufacturing capacity to 805,000 tons a year.

Of this total, 705,000 tons were to be in general-purpose rubber—designated GR-S—and 100,000 tons in neoprene and butyl. The job of designing and building the new GR-S copolymer plants was given to the rubber industry.

The petroleum and chemical industries had tremendous jobs to do to bring in matching capacities for feed stocks used in making synthetic rubber. Under all-out emergency pressure, pilot-plant operations were completed and volume production of GR-S was under way before the end of 1943.

"The exceedingly critical conditions under which the rubber industry supplied our World War II needs are not likely to recur. Today we have a general-purpose synthetic-rubber copolymer capacity, Government-owned and operated by members of the rubber industry, totaling 860,000 long tons a year and a butyl capacity of 80,000 tons a year."

At the time of Pearl Harbor the United States had a stock pile of natural rubber—including that in the hands of manufacturers and afloat—of 640,000 tons, or 12 months' supply at the 1941 rate of consumption. We were faced with having to stretch supplies until synthetic plants could be brought into volume operation on a new product *and until the industry could learn to use the new product.*

Supplies Cut Off

All our larger sources of natural rubber were very quickly cut off. The natural rubber which reached this country thereafter came principally from wild rubber trees in South America and from the Firestone plantations in Liberia, West Africa.

The supply problem of the rubber industry in World War II was not confined to building the new synthetic plants and getting them into operation. As I mentioned before, the GR-S synthetic was a new product. New compounding, processing, and tire-building techniques had to be developed before the industry could use it to make good tires.

The size of this job cannot be appreciated by any one who did not have a part in it. Possibly it is illustrated best by the fact that the German rubber people themselves—the originators of this type of synthetic—would not believe that the American jeeps and command cars rolling at high speeds up and down the autobahns were using tires made with over ninety per cent of synthetic rubber.

In this connection I might mention that in Germany the production of synthetic rubber was in the hands of the chemical industry. The rubber-processing companies were handed the synthetic on the basis that "this is it—now you use it."

In our country, of course, the rubber industry had the responsibility both of making and using synthetic and the corresponding opportunity to "tailor" the raw material to best advantage.

Huge Capacity

The exceedingly critical conditions under which the rubber industry supplied our World War II needs are not likely to recur. Today we have a general-purpose synthetic rubber copolymer capacity, Government-owned and operated by members of the rubber industry, totaling 860,000 long tons a year and a butyl capacity of 80,000 tons a year.

In addition, private industry owns sufficient facilities for the manufacture of specialty synthetic rubbers to bring total U.S.A. synthetic-rubber capacity to more than 1,000,000 long tons yearly. Compare this with the 12,000 tons of special-purpose synthetic rubber capacity which existed at the time of Pearl Harbor.

There is yet another significant and favorable factor in the synthetic-rubber picture. The GR-S of World War II had neither the strength nor the durability of natural rubber. In the years between, the rubber industry has developed various types of general-purpose synthetics. Perhaps the most significant of these is what we know to-

day as "cold" rubber. This rubber is similar in composition to regular general-purpose synthetic. It is, however, polymerized at lower temperatures, and the result is a rubber that is stronger and more resistant to abrasion.

Mileage Increased

Cold rubber, compounded as if it were regular GR-S, increased tire-tread mileage about ten per cent. And when compounded with new types of pigments, it affords a twenty-five to thirty per cent improvement over former synthetic compounds in tire-tread mileage.

Incidentally, cold rubber is a result of an industry-wide research and development program coördinated by the Reconstruction Finance Corporation.

Today there are many places in which some synthetic rubber, general-purpose or otherwise, will do the job for which it is specifically made as well as natural rubber, or better.

Butyl, a synthetic used principally for inner tubes, is one example. It holds air ten times as long as natural rubber. When first developed and put to use during World War II, it had a tendency to buckle and fail in extreme cold. Elimination of these shortcomings in butyl has been one of the great advances in synthetic-rubber technology since Pearl Harbor.

Because of the ability to control and vary the man-made product, we may expect continuing developments in the field of tailoring synthetics to requirements of specific applications.

The chief disadvantage of synthetic rubber today is that large tires with thick sidewalls and treads generate more heat when made with synthetic than they do when made with natural rubber.

The Next Step

The next major step in making our country more secure with respect to rubber may be the development of a synthetic fully suitable for use in large multiple-ply truck and military tires.

We believe that such major improvements will come about more quickly if synthetic-rubber manufacture is transferred to private industry. The Rubber Act of 1948, which I have already mentioned, establishes as a policy that we maintain a technologically advanced and rapidly expandable rubber-producing industry in the United States. The act further states the view that this end will best be served by the development, ultimately, of a free, competitive synthetic-rubber industry.

For the present, however, the law restricts the sale of the synthetic plants to industry. This act is due for review in 1953, and I firmly believe that the time has arrived when these plants should be sold, under adequate security provisions, to private industry.

As I mentioned previously, natural rubber is still superior to synthetic in large tires having many plies. It is still advantageous for ply cements used in building all sizes of tires. So some natural rubber, starting with one to two per cent in passenger tires and increasing as tire sizes increase, is still needed if tires are to give the ultimate in performance.

What of Natural Rubber?

And what is the situation with respect to natural rubber? Well, we went into World War II with a total stock pile, including rubber in the hands of manufacturers and afloat, of a bit more than 640,000 tons. Today we have a national stock pile in the hands of our Government, the size of which has not been made public.

However, indications are that the Government stock pile now exceeds one million tons. With the synthetic plant capacities in existence today, this should be enough to sustain a war effort of at least five years, even though no added quantities of natural rubber were to be received in this country.

In addition, it is estimated that there are approximately 150,000 tons of natural rubber in the hands of the rubber industry and enroute to this country.

During World War II, Firestone plantations in Liberia were our country's only source of natural rubber latex, required for medical rubber goods and for insulation of special types of wire used in combat. These plantations also contributed substantial quantities of dry rubber. Without them our World War II national stock pile would have been exhausted by the end of the war. These plantations now have mature acreage sufficient to increase their output by one hundred per cent over peak production in World War II.

What about the ability of the rubber industry to fabricate these increased supplies of rubber into the sizes and type of tires required for the armed forces? The tire-manufacturing capacity of most interest to the armed forces is in sizes larger than passenger tires. At the beginning of World War II the industry's capacity in these sizes was approximately 40,000 tires a day. This capacity is now 70,000 tires a day—an increase of 75 per cent since December 1941. Passenger-tire capacities have been increased approximately thirty per cent.

Basic compounding, mixing, and milling facilities have been extended to balance both these expansions. If it became necessary to convert small tire building and curing capacity to the larger sizes, such an undertaking would not be nearly so difficult as if we had to provide the basic mixing and milling facilities.

Position Gratifying

To summarize briefly the position of our country and its rubber industry today, as compared with 1941, it is gratifying to note that we have:

1. A larger natural rubber stock pile, sufficient in itself to sustain a 5-year war effort.

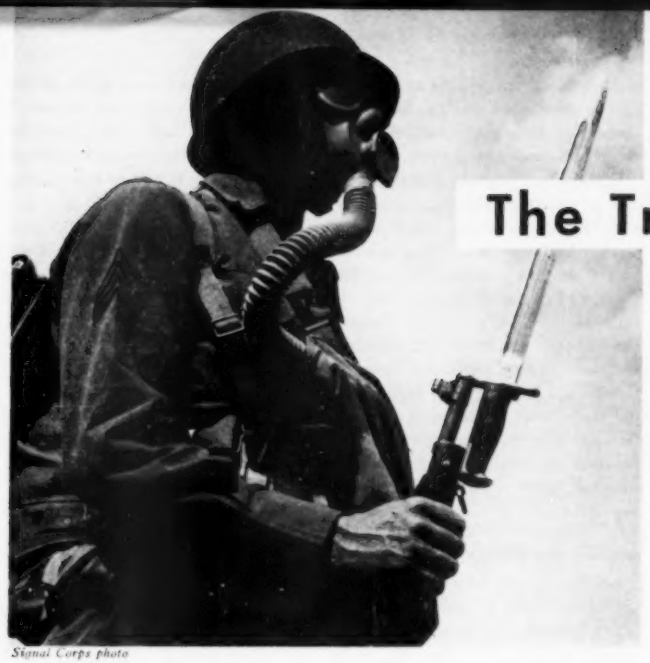
2. A synthetic-rubber-producing capacity of more than a million tons a year, compared with an annual capacity of 12,000 tons in 1941.

3. Improved synthetic rubbers that have the effect of increasing still further our supply position as compared with 1941.

4. The know-how to make good products out of synthetic rubber compared with our having to "start from scratch" in 1941.

5. Increased capacity—by seventy-five per cent in sizes most critical for a war effort—for converting our rubber supplies into tires and tubes.

Therefore, I can say with assurance that our country's rubber industry is well prepared to serve its needs either in war or peace.



Signal Corps photo

The Truth about Biological Warfare

Brig. Gen. William M. Creasy

Commanding General, Chemical Corps Research and Engineering Command, Army Chemical Center, Md.

THE expression "biological warfare" has, in the past few years, captured the interest of citizens throughout the United States. Many sensational articles have been published, some of them inaccurate and misleading, and it is my hope to correct any false impressions which may have been created.

Government's Position

The official position of our Government is expressed in a manual entitled, "Health Services and Special Weapons Defense." This manual explicitly states that "an enemy . . . could employ . . . biological warfare against us effectively."

The concept of biological warfare is not new. Even with no assistance from man, germs have taken part in every major military campaign. Plague felled the Crusaders at the gates of Jerusalem. Typhus riddled the Moors in Spain, and dysentery thinned the ranks of Napoleon's Grand Army as it moved on Moscow. During the Boer War, typhoid fever laid low more men than did bullets. In the early days of World War II, malaria heavily attacked our own forces in the South Pacific.

Microbes, not military strategy, have more than once determined the final results of a conflict. But these have been naturally occurring outbreaks and epidemics, and against these our defenses are good and are getting better.

Some small-scale biological warfare attacks are known to have been attempted. Before our entry into World War I, secret agents working in the United States infected livestock with a disease called glanders as the animals were being prepared for shipment to the Allied nations of Europe.

Those attacks were very crude. They had no real effect on the outcome of the war, since only a few animals were infected. The saboteurs depended on natural spread to accomplish large-scale infection. Such attacks hold little danger or promise—depending on the point of view—of really sweeping results.

Now I would like to mention briefly and dispose of two of the more sensational aspects of biological warfare. These are the concepts of "supervirulence" and epidemicity.

Publications by reputable authorities on biological warfare have not, at any time, mentioned hypothetical new agents of unknown characteristics or supervirulence. Therefore, it seems probable that such a notion lies in the realm of pure speculation.

Furthermore, most authorities consider it questionable that a self-propagating epidemic must be anticipated. First, they doubt that such an epidemic could be started and, secondly, they feel that a strengthened public health organization could promptly control one if it did occur.

Epidemic Averted

Let us consider one example of the workings of our nationwide system to prevent and control disease outbreaks of all kinds. In 1947 a visitor to New York City was discovered to have an active case of smallpox. This man had traveled within the city, shopped in its stores, and made extensive use of the crowded transportation system. He unquestionably came into direct contact with hundreds of New Yorkers during the several days in which he was, in effect, a disseminator of BW. But prompt preventive measures, including vaccination of more than six million people, limited secondary outbreaks of

this contagious disease to only twelve cases.

If we accept this efficient operation of our public health authorities as typical—and I believe we can—and if we quite properly ignore such figments as supervirulence, we can then focus our attention on the real and the practical.

Question Disputed

The importance of air as a means of spread of naturally occurring disease has been a moot question over a long period of time. This disputed question has been given intensive study during the past fifteen years, and it still remains to be conclusively proved that the airborne route is an important factor in the spread of naturally occurring disease.

However, knowledge accumulated during this period has clearly established some of the mechanisms of airborne infection. Airborne spread of disease is a reality in the experimental laboratory and is known to be a common cause of many accidental human infections. The fact that the hazard of aërial contamination is widely accepted is indicated by the extreme precautions that are taken not only in the study of highly infectious agents but also in dealing with routine hospital problems.

The size of single bacterial cells, fungal spores, rickettsiae, and virus elementary bodies is somewhere under five microns. This is an ideal size to permit such single particles to penetrate to the lungs.

However, pathogenic agents rarely exist as single cells under normal conditions; instead, they have a tendency to agglomerate, or to form clumps or chains. In addition, they are most often intimately mixed with moist organic matter and, when naturally expelled into the open, tend to adhere rapidly to dust or lint particles and become still larger, thereby greatly hindering their penetration.

It would seem to be entirely reasonable to conclude that, under natural circumstances, single pathogenic cells are only rarely dispersed into the air. Therefore, human beings have not been forced to contend with a wide variety of finely dispersed aërosols and consequently have not faced the biological necessity of developing a natural mechanism of defense against them.

However, an entirely different picture is presented when one considers artificial circumstances, since many pathogenic agents may be grown in almost limitless quantities and may be dispersed into the air as single cells. In spite of the body's physical defense mechanisms, which would probably trap and render ineffective most of these cells, enough of them might reach the lungs to cause infection. The intentional propagation of clouds of individual cells would then be one of the most important objectives of biological warfare.

Method Not Attempted

So far as we know, the aërosol method of spreading pathogenic microorganisms has never been attempted in actual warfare. We do not know whether it ever will be tried, but, apparently, it could be used, and we must make our preparations with that in mind.

Let us consider, then, how an enemy could use the airborne route of infection in biological warfare against man. The frequency with which certain infections, some of them fatal, occur among laboratory workers indicates that a considerable proportion of the adult population of this country is susceptible to these diseases under such conditions of exposure.

Typical of such conditions is the grinding of infectious tissue which has been found to contaminate a room, or the concentration of pathogenic agents in a centrifuge which has been known to contaminate an entire building. The question is: Can an enemy reproduce at will the conditions known to cause accidental laboratory infections?

No New Principles

It appears that no new principles are involved. In fact, atomizers or other disseminating devices could be used to produce even greater concentrations of infectious clouds. Relatively simple equipment which could be carried in an ordinary suitcase would be sufficient to enable a saboteur to contaminate the air of any enclosed space where people congregate and could cause an attack rate of disease as high as or higher than that observed in the fulminating laboratory epidemics which occur periodically.

These same principles hold true, but on a larger scale, for the use of aërosol clouds over cities. Specially designed bombs, shells, or other types of disseminating devices discharged from enemy aircraft or from warships offshore could create large clouds.

Under weather conditions which are not too rare, such clouds would remain close to the ground and, like pollen, diffuse with the wind over wide areas, or like smog, hang over a city for hours. An excellent example of this type of smog occurred at Donora, Pa., several years ago.

With disseminating devices of reasonable size, relatively small amounts of material could be used to establish widespread clouds with high concentrations of agent. The problem of spreading the agent would be one of practical technical development rather than one requiring any new or undiscovered scientific principles.

It would seem entirely possible that the percentage of casualties among those exposed to such a cloud attack might approach that which could be produced from the over-all contamination of a building by saboteurs.

Contaminating Water

The introduction of a relatively small volume of a highly concentrated suspension of a pure BW agent into the water-distribution system of a city could effectively contaminate a large part of that system. The principles of backsiphonage are sufficiently well known so that any plumber or person with a minimum of sanitary-engineering training could introduce such a mixture.

The exact point of insertion into the system might be exceedingly difficult to locate and, of course, a larger number of casualties would be expected than would occur in accidental waterborne infections since the dosage of agent received by consumers would be sufficiently great to overcome any natural resistance.

Food-borne epidemics are well understood. They usually result from the contamination of certain types of warm or moist foods that provide growth conditions required by the bacteriological agent. The number of organisms may be small to begin with, but the final concentration in the food actually consumed may be tremendous due to the opportunities for growth in the meantime.

Resistance Overcome

In several reported food-borne epidemics of typhoid fever, a majority of the persons consuming the contaminated food were affected, indicating again that high concentrations of bacteria could overcome much of the natural resistance which the normal population may have.

We can readily see that a high concentration of certain infectious agents injected into the right food at the right time by a saboteur would almost certainly produce high attack rates among those who consume the food.

Our potential enemies have capabilities in the field of sabotage not shared by ourselves and our allies. One's imagination may be given free rein when one considers the wide variety of possibilities and potentialities of this form of warfare. The only limiting factors are the accessibility of food and water supplies to a subversive agent and the extent of the distribution of any single food or water supply.

However, it should be noted that such sabotage methods would not necessarily be limited to the use of pathogens. Certain bacterial and vegetable toxins, or any of a wide variety of chemical poisons, might be used. From the saboteur's point of view, though, biological agents have distinct advantages over the chemical poisons. The incubation periods of the biological agents vary from days to weeks, which would enable him to perform his mission and disappear, leaving few clues. The more immediate effects of chemical poisons might increase his chances of detection.

A man whose strong build testifies to his ability to defend himself against attack is seldom set upon by another. Similarly, our best method of assuring that we will not be attacked is for all our real or potential enemies to know that we are capable of protecting ourselves adequately against biological warfare and, if necessary, that this protection need not be a passive one.

One of the best defenses against a bacteriological attack is a quick, reliable detection system so that appropriate public health organizations can swing into action promptly and initiate antibiotic, chemotherapeutic, and other suitable control measures. It is clear that the initiation of such widespread control procedures would be no small task.

"A man whose strong build testifies to his ability to defend himself against attack is seldom set upon by another. Similarly, our best method of assuring that we will not be attacked is for all our real or potential enemies to know that we are capable of protecting ourselves adequately against biological warfare and, if necessary, that this protection need not be a passive one."

Rapid Identification

Until recently, standard procedures for detecting these organisms in water required four days. However the Chemical Corps recently completed development of a revolutionary detection device, consisting of a very thin filter which will trap bacteria and permit their identification within fifteen hours, or one-sixth the time previously required. There is still a requirement for the development of more and quicker specific tests for all potential biological-warfare agents. Both the Chemical Corps and the Public Health Service are vigorously pushing such development.

May Infect Animals

However, the enemy need not direct his attack toward the human population of the country. His intent may be not an immediate effect, but a long-range effect, produced by infecting our domestic animals with exotic diseases not now present in the United States and, as a result, cutting down our meat supply.

One can realize the damage that such an overt or covert attack might produce by considering the cost of bringing the recent outbreak of foot-and-mouth disease in Mexico under control. This outbreak resulted in the loss of more than a million animals, and produced a joint economic loss of two hundred million dollars to Mexico and the United States. This disease and the equally dangerous rinderpest are highly contagious and would spread rapidly from herd to herd.

Threat Can Be Answered

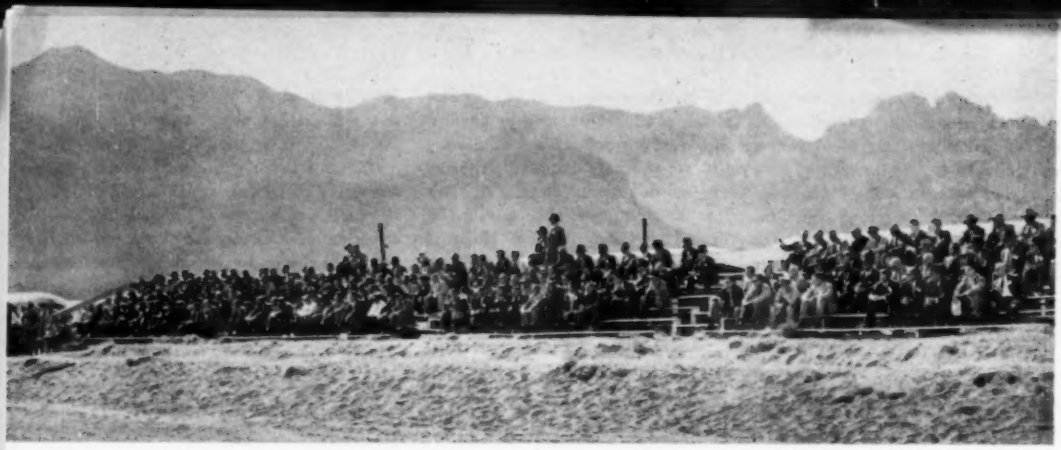
This threat can be answered by strengthening our existing animal disease control organizations. Many agencies are currently coöperating in the development of new and improved vaccines to satisfy this continuing need.

In addition to our domestic animals, our crops are similarly vulnerable to attack by exotic biological agents not now a problem in this country. Enemy aircraft or saboteurs could introduce destructive plant diseases and pests into our corn and wheat belts which might be difficult, if not impossible, to bring under control before the year's crop was ruined.

Here, too, the answer to the threat lies in increasing the strength of our existing organization for the control of plant disease so that outbreaks can be promptly reported and control measures initiated. One facet of the defensive picture which is receiving the attention of many coöperating agencies is the development of additional disease-resistant plant varieties.

Possibilities Great

These are but a few highlights of factual information about biological warfare, unadorned by sensationalism or exaggeration. Its possibilities are great—do not be misled on that score—but they are frightening only if we fail to insure that we are ahead of any other nation in knowledge and preparedness in this field.



Ordnance at White Sands

A.O.A. Holds First Regional Meeting in the Southwest

WHEN some 400 members of the American Ordnance Association assembled at White Sands Proving Ground on November 7, 1952, they established a new record in the annals of the Association. It was the first regional meeting to be held in the southwestern part of the United States and also the first 2-day gathering devoted to the study of rockets and guided missiles.

Directed by General Eddy

The entire program was under the capable and kindly direction of Brig. Gen. George G. Eddy, commanding general at White Sands. A charter member of the Ordnance Association, General Eddy is known throughout the Ordnance fraternity for his ability as an ordnance engineer and administrator and his outstanding service to American industry and to the armed forces in this country and abroad. The meeting began at El Paso, Tex., on the afternoon of November 6th and concluded the following evening at White Sands.

Los Angeles Delegation

Noteworthy among the attendance was a large delegation of members from the Los Angeles Post, under the leadership of Post President William A. Wilson. The Los Angeles delegation made the journey by chartered airplane.

The afternoon of the first day of the meeting was devoted to a seminar on guided missiles under the chairmanship of General Eddy. The seminar was held in the ballroom of the Cortez Hotel, El Paso, and was attended by approximately 300 members and guests. Other speakers were Maj. R. A. McDonough, chief technical training officer at White Sands; Lieut. Col. W. P. Patterson, chief of the proving ground's technical staff; and J. J. Putegnat, also of the technical staff.

Seminar Topics

Major McDonough's topic was "What Is a Guided Missile"; Colonel Patterson spoke on "Guided Missile Testing"; and Mr. Putegnat discussed "Reliability, Quality, and Control of Missiles."

Brig. Gen. G. G. Eddy welcomes A.O.A. members to seminar at Hotel Cortez, El Paso, Tex. On his left are Maj. R. A. McDonough, Lieut. Col. W. P. Patterson, and J. J. Putegnat, all of White Sands Proving Ground, who also spoke at the seminar.

The seminar was opened by Chris P. Fox, well-known El Paso civic leader, city official, and businessman, who welcomed the visitors. Mr. Fox also presided in a most hospitable way as chairman of the banquet in the evening.

Louis Polk, vice-president of the American Ordnance Association in charge of Technical Divisions and Committees and president of the Sheffield Corporation, Dayton, Ohio, concluded the seminar with thanks on behalf of the Association to General Eddy and his associates.

Chris P. Fox, shown at the rostrum, above, served as toastmaster at the A.O.A. banquet held at the Hotel Cortez in El Paso on the evening of November 6th.

Committee Meeting Held

Preceding the seminar a noteworthy meeting of the A.O.A. Rocket and Jato Committee, under the chairmanship of C. L. Eksergian, Budd Company, Philadelphia, Pa., was held at which nearly one hundred members of the Committee were present.

Weber deVore, Heintz Manufacturing Company, Philadelphia, secretary of the Committee, and Brig. Gen. Burton O. Lewis, staff consultant, American Ordnance Association, were in general charge of the program.

The new Post of the Ordnance Association with headquarters in El Paso was inaugurated at the dinner meeting on the evening of November 6th at the Cortez. Mr. Fox was a delightful master of ceremonies. Principal addresses were given by General Eddy; Rear Admiral W. V. Davis, deputy commander for the Armed Forces Special Weapons Project at Sandia Base, Albuquerque, N. Mex.; Brig. Gen. Edward P. Mechling, commanding general, Air Armament Test Center, Eglin Field, Fla.; and Robert L. Biggers, vice-president of the Association and president of Fargo Division, Chrysler Corporation, Detroit, Mich.

Charter Presented

The charter of the new Post was presented by Leo A. Codd, executive vice-president of the American Ordnance Association, Washington, D. C. The charter was accepted by the chairman of the Post's Organization Committee, Col. Henry E. Minton, for many years an active Regular officer of the Ordnance Department of the Army and now an insurance executive in El Paso.

In general charge of the El Paso phase of the meeting were Colonel Minton; M. S. Darbyshire, president of Darbyshire Steel Company; and C. A. Lindeman, also of the Darbyshire organization.

Special Guests

Among the special guests at the dinner in addition to those named above were: Henry N. Marsh, general chairman of Technical Divisions and Committees, American Ordnance Association, and an official of Hercules Powder Company, Wilmington, Del.; Brig. Gen. Thomas C. Musgrave, commanding general, 47th Air Division, Walker Air Force Base, N. Mex.; Col. D. R. Ostrander, commanding the Holloman Air Development Center, Alamogordo, N. Mex.; Capt. P. D. Quirk, commanding, U. S. Naval Ordnance Missile Test Facility, White Sands Proving Ground; A. N. Kemp, chairman of the board, Pacific Mutual Life Insurance Company, Los Angeles; Col. W. S. Broberg, chief, Los Angeles Ordnance District; Capt. B. L. Lubelsky, commanding officer, U. S. Ammunition Depot, McAlester, Okla.; Brig. Gen. Hobart Hewitt, Eglin Air Force Base, Fla.; and Capt. Walter L. Tann, Bureau of Ordnance, Navy Department, Washington, D. C.

Next morning, Friday, November 7th, members and guests journeyed some sixty-five miles in chartered buses from El Paso to White Sands for a program of tests and demonstrations long to be remembered. The program began at the Post theater under the auspices of General Eddy, assisted by Col. John G. Shinkle, deputy commanding officer of White Sands Proving Ground. The operation of rockets and guided missiles was demonstrated in two films —"Operation Greenhouse" and "The V-2 in Upper Atmosphere Research."

Following this demonstration the party went to the "Honest John" view site to witness the firing of two of the latest large rockets. Next came a journey to the static test stand where static rocket firing was demonstrated and explained.

Preceding luncheon there was a display of missiles and missile equipment after which a chuck-wagon luncheon was served.

The afternoon program was devoted to a journey to the Nike view site from which the shooting of the Nike guided missile could be observed.

Hospitality Praised

At sundown the guests returned to El Paso loud in their praises for the hospitality and efficiency of the White Sands organization under the direction of General Eddy, aided so capably by Colonel Ostrander for the Air Force and Captain Quirk for the Navy. They were also indebted greatly to Carl Lindeman who carried without a flaw the burden for the details of the 2-day operation.

The first regional meeting of the Ordnance Association at the White Sands Proving Ground, N. Mex., goes down in the book as one of the most instructive and enjoyable ever held under the auspices of the A.O.A.

GI Ordnance Scientists

by

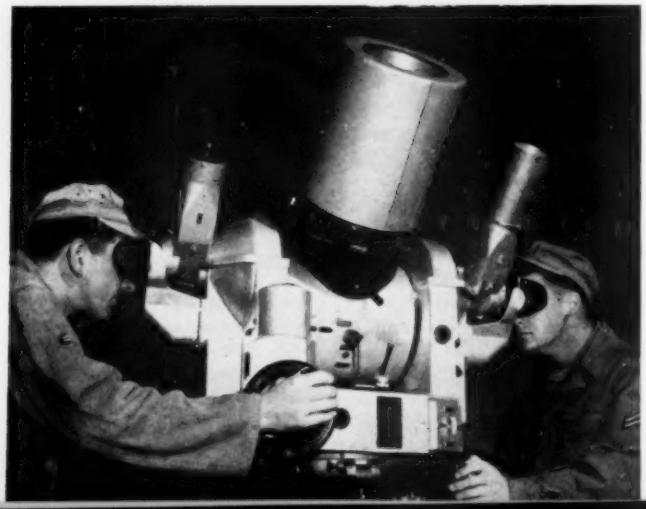
Brig. Gen. George G. Eddy

Commanding White Sands Proving Ground, Las Cruces, N. Mex.

Young Ordnance soldier-technicians are doing outstanding work preparing and firing guided missiles

Above, GI-trained scientists prepare to launch a German V-2 rocket in the first all-soldier attempt to assemble and fire guided missiles at White Sands, N. Mex.

Above, Pfc. John Woods follows behavior of guided missile with a teleplotter. Below, GI's track rocket with Askania optical instrumentation camera.



THE commonly accepted mental picture of the wartime foot soldier, who involuntarily entered military service to spend his training period issuing unintelligible grunts as he marched countless miles with a field pack and gun on his back, has become obsolete at White Sands Proving Ground, N. Mex. Here, in this isolated Army Ordnance guided missile research and development facility, is a new type of soldier who has been trained as a scientific technician. To him the entire world of freedom-loving peoples look for protection in troubled times.

Ordinary Backgrounds

These young technicians in khaki, volunteers and inductees, little resemble the usual scientist—a cross between the absent-minded professor and the elderly genius surrounded by test tubes. These youngsters, most of whom are in their early twenties, are as ordinary in educational training and background as the boy next door. Every race, creed, and nationality works side by side in this newest field of defensive warfare.

The young soldier-technicians at

White Sands Proving Ground come from every State in the Union and from every walk of life. Former farm boys, grocery clerks, miners, mechanics, and students, have, through their special military training, become a backlog of scientists for the future through the specialized training provided by Army Ordnance.

Ideas Upset

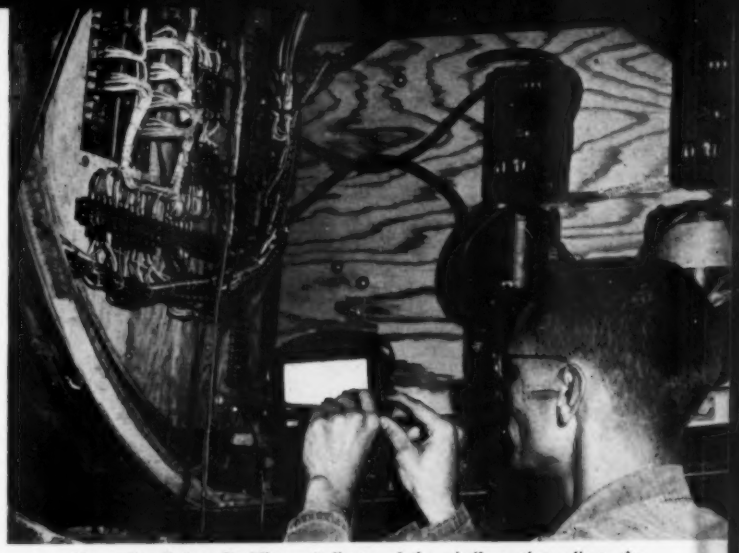
Heretofore the public generally accepted the theory that only scientists of established repute and with many years of experience were capable of developing, testing, and launching guided missiles. The young soldiers at White Sands Proving Ground upset the world's preconceived ideas when, after intensive training, they took over, as a completely military unit, the assembly and launching of a German V-2 rocket to further the American guided missile program following World War II.

Scientists and laymen throughout the world were electrified on February 24, 1949, by the public announcement of the record-breaking flight of the first 2-stage rocket at the proving ground, then almost unknown as a research and testing facility.

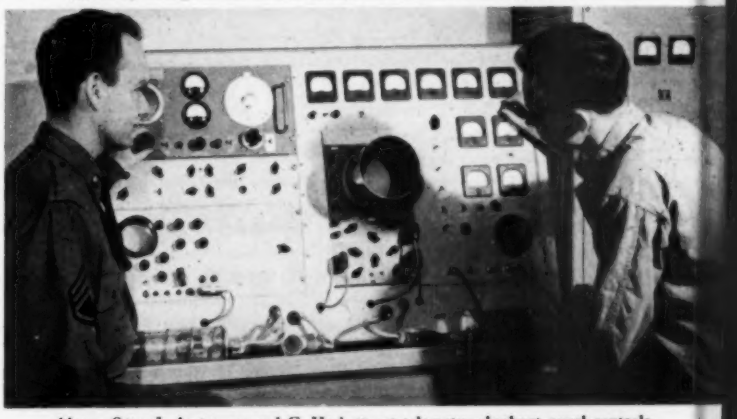
Until that date, only scientists of established repute, mostly German militarists or civilian contractors, had successfully designed, tested, and fired guided missiles. With the advent of the Army Ordnance training program for servicemen at White Sands Proving Ground, a new field was opened in educational benefits for the enlisted soldier as well as for national defense.

First 2-Stage Missile

The first amazing 2-stage missile mission for the newly trained Ordnancemen was the Wac Corporal and V-2 combination, the former on the nose of the latter which acted as a booster unit. Both contained modern scientific instruments for recording flight data which were to be of inestimable value in further research and development. With the newly gained scientific know-how of these young soldier technicians, this bumper rocket attained a height of 250 miles—the highest altitude yet reached by a man-made missile. Another "first" for the enlisted men's sci-



Above, Sgt. Robert P. Alley, coördinator of the missile section, adjusts the telemetry voltage in the control compartment of the rocket just before firing.



Above, Sgts. J. Angerman and C. Haskett set telemetry checkout panel controls. Below, Pfc. D. Estabrook presses firing button sending a test rocket skyward.

entific achievements was the firing of the first Aerobee missile at White Sands Proving Ground, an assignment in which both primary and secondary jobs for the preparation and launching were filled by an 11-man enlisted crew under the direction of a military project officer. The Aerobee is extremely valuable in the study of scientific atmospheric conditions.

A New Era

The rocket flights carried out by these young soldiers opens a new era in the field of fundamental scientific research.

Since World War II, rapid strides have been made at White Sands Proving Ground in gaining basic knowledge of materials essential for propulsion devices, equipment for remote control, and the aërodynamics of guided missiles. These intricate technical problems are being dealt with through the unification of every branch of the military service at White Sands.

The first all-military mission, consisting of thirty-two men, was launched into the desert air to begin a threefold program: (1) Experiments for the Army Ordnance Corps, (2) maintenance of a practical laboratory for scientific investigation of the upper atmosphere, and (3) training of other military personnel, for both research and the practical field use of guided missiles.

Due to the inevitable and regular turnover of military personnel, Army Ordnance must provide a continual replacement training program, the benefits of which dischargees carry back to civil life or follow up with further military service.

Outstanding Feature

Perhaps the most outstanding feature of White Sands Proving Ground's missile program is the cross section of America's youth who make it possible through their specialized Army training. The program at the desert base has proved how successfully scientific attitudes and techniques may be applied to unfamiliar assignments by the average young man in military service. In most cases these soldiers are working out of fields they might have followed in civil life. Many will continue to follow science in varied aspects because of the interest gained during their military service.

Key figures among the enlisted scientific technicians in the early history of the White Sands program were Sgt. Robert P. Alley and Pfc. Donald M. Estabrook. Private Estabrook was the "triggerman" for the first firing of a missile by an all-soldier crew at the proving ground. Sergeant Alley served as coördinator for the missile program from its inception. He also served as liaison between the missile section and other sections related to the program and its personnel. His uncanny calculations on missile performance have become legendary at the Proving Ground.

Design and Develop

Not only do these soldier technicians develop, test, and fire our newest defense weapon, but in some cases they also design and construct the equipment necessary to the program. Such is the case with 24-year-old Cpl. Don Fapiano who is assigned as liaison between the General Electric Company and Army Ordnance in combining the specifications of both to design a gantry crane for missiles of a given size.

Operation of rare equipment is no longer exceptional at White Sands where Pfc. John Woods operates one of the three teleplotters in the United States. This electronic device tells the story of a fired rocket, giving its location, angle, velocity, total speed, and acceleration each second it is in the air.

Rocket firings are useless without means and personnel to record data. Sgt. Joe Angerman and Sgt. Carl Haskett perform valuable work in operation of the telemetry panel which portrays, on a screen similar to television, the behavior of each missile while it is in the air.

Equally important are the assignments of Cpl. Jack Hart and Cpl. Bill Robe, optical instrumentation technicians, and Cpl. Arnold Bottari, gyroscope technician.

Peacetime Benefits

The enlisted scientific soldier technicians at White Sands Proving Ground are providing innumerable benefits for peacetime in addition to training for military protection. They provide instruments to measure cosmic radiation; record spectra of the sun; photograph large areas of the earth; measure temperatures and pressures, sky brightness, radio and radar wave propagation; test parachutes; measure the earth's magnetic field; and measure spark-gap breakdowns at the extremely low pressure areas encountered high above the earth.

New Educational Field

The future value of the Ordnance-trained soldier at White Sands Proving Ground will undoubtedly become a yardstick for scientific research while the basic fundamental knowledge gained by young men from every State and every walk of life will provide a new educational field for the Ordnance soldier.

Operating under the call letters, MARS, Pfc. Lloyd A. Burrows provides worldwide radio and information service for the White Sands guided-missile program.

Army photo

Industrial Manpower

Our Defense Production Creates New Personnel Problems

by

Paul B. Smith

The available labor supply should be utilized to the fullest extent before additional employment requirements are created in areas of labor stringency

AS one of the Nation's major resources, manpower has a vital rôle in the defense program. The size, capacity, and skill of our working population constitute an important factor in building and maintaining our national strength. As a resource, however, manpower differs significantly from all other economic factors because it involves a human element and must be developed, conserved, and used with great skill and foresight.

Heavy Demands

Although the goal of the present defense effort is partial mobilization, its requirements have been superimposed on a high-level civilian economy. This combined productive effort has created heavy manpower demands in meeting the requirements of the armed services, in staffing expanding defense industries, and maintaining adequate levels of output of essential civilian goods and services.

It is against this background that some of the more significant manpower developments and programs will be presented with special reference to Ordnance procurement.

Mr. Smith is manpower liaison representative between the United States Employment Service and the Ordnance Corps of the Army.

Assumptions for 1953

During the coming year it is assumed: (1) that our mobilization program will proceed according to present schedule and that even cessation of hostilities in Korea will not result in any significant change either in the size of the defense program or in its scheduled timing, and (2) that easier supplies of materials and rising consumer income will result in increased civilian production above current levels.

Defense production in 1953 is ex-

pected to reach its peak and level off. As the plateau is reached, the emphasis on various military end items will shift. As a result, some defense production will continue to expand and require additional workers, while other phases will decline and release workers.

Employment in consumer durable goods is expected to be generally somewhat higher than the current work force as a greater supply of basic metals becomes available for such production. As structural steel for construction purposes is expected to be more plentiful, the level of construction activity should be only slightly below that of 1952.

Consumer soft-goods employment is also expected to be relatively high. With respect to agriculture, the labor force is expected to decline over the next year due to the continued competition of nonagricultural establishments for workers.

The combined labor needs of defense industry and civilian activities have already pushed employment to record levels, and a further rise is anticipated this year. To meet this need the civilian labor force will have to expand by some 700,000 to 800,000 workers. Fortunately the normal net growth in the labor force will provide this number, for it is unlikely that unemployment will decline much below current levels (around 1.3 million) under peacetime conditions.

Thus, on an over-all national basis, our manpower supply, if effectively utilized, will be adequate to meet the anticipated combined needs of defense and civilian production and maintain our armed forces at approximately 3,700,000. However, manpower stringencies will continue in a number of major industrial areas as well as in certain critical occupations.

Production Unimpeded

Despite these occupational stringencies, labor shortages are not yet holding back production of military material. Actually, we shall continue to see spotty increases in unemployment as a result of fluctuations in the civilian-goods markets and, to some extent, from controls on the use of basic materials.

In general, however, no sharp change in the level of economic activity appears likely to occur in the next two years. But as different parts of the economy undergo individual adjustments at various times with corresponding impact on the labor force, manpower programs must be geared accordingly.

Before proceeding with a discussion of specific manpower problems and programs, a brief summary of employment developments in ordnance and accessories manufacturing should be of particular interest.

Manpower reports received in late September from 131 ordnance plants and arsenals, employing 286,600 workers, indicated an employment upswing during the closing months of 1952. Expansion, of course, has slowed considerably since the rapid post-Korean build-up.

Increases Expected

However, all branches of the industry anticipated substantial employment increases, with private plants expecting to add ten per cent more workers and Government establishments planning to increase their work forces by four per cent between September 1952 and March 1953.

Obviously, tied to changing military needs, most of the increase anticipated in September was based on the filling out of production lines which were already in operation. At the same time some plants were still in the process of building new capacity and based their estimates on anticipated staffing of these new production lines.

More significantly, September employment in Government establishments was approximately six per cent greater than a year ago while private plants had upped their employment by more than seventy-three per cent over the year.

As a result, current and future manpower developments in the ordnance-manufacturing industry will be dominated more and more by changes in the manpower requirements of private plants which are providing an increasing portion of the jobs in the industry.

Labor shortages in the ordnance industry continued to be widespread, although generally limited to professional, technical, and skilled occupations and not severe enough to hold down production in most plants. Six out of every ten establishments reported job openings which were hard to fill—many existing for long periods of time. On the other hand, only five plants indicated that manpower difficulties were sufficiently great to impede production.

Skills Scarce

Changing designs, rigid performance standards, and complexity of many modern weapons require the kinds of skills which are in short supply in all metalworking industries. Most frequently occurring occupational shortages were those of engineers, machinists, and machine-tool operators, tool- and diemakers, and tool designers.

While the above summary is based on data and findings during the third quarter of 1952, the same conditions are expected to prevail in the industry during the coming year. Hence the industry to a considerable extent reflects the over-all manpower pattern described at the outset.

The foregoing summary of economic and labor market trends for the year ahead only suggests the broad context in which specific manpower problems have been developing. Although no manpower difficulties of crisis proportions are anticipated in the immediate future, some problems have already emerged which warrant serious concern and effective remedial action.

Effect of Rotation

While the armed forces have already reached their desired levels, a considerable movement of personnel will continue to take place due to the military service policy of rotation. Almost a million men will be returned to civilian life, replacing those entering military service. Although many separatees will resume their education, the vast majority will enter the labor market.

They, along with the thousands of persons who will actively seek work for the first time and the thousands of workers who shift jobs, present a sizable recruitment, placement, and training

challenge to manpower facilities. This will pose a complex problem of matching skills with jobs available at the right time and in the right places.

Shortages May Continue

As indicated in previous articles in ORDNANCE magazine, shortages of scientific and engineering personnel, currently being experienced, are likely to continue for some time. Considerable progress has been made since the publication of these articles in improving the utilization of these key workers at their highest capacity and in activities vital to our national security through the coöperation of the professional societies, management, and Government.

Nevertheless, expansion of industrial facilities, changing civilian products, and the new design and character of military weapons reflect continued needs, not only for professional specialists but for such skilled workers as machinists, tool- and diemakers, layout men, pattern makers, and electronic technicians, the supply of whom cannot be augmented quickly.

There are over sixty occupations on the list of critical occupations prepared by the Department of Labor, which means that there is not an adequate supply of workers having these skills even for the present level of mobilization.

Labor Not as Mobile

Another development since the war years which makes our current manpower job difficult is the fact that labor is not as mobile as it was ten or twelve years ago. Many more employees have seniority, pension, and insurance rights protected by bargaining agreements and are reluctant to transfer to defense employment unless these rights are protected.

In general, therefore, the labor market will be characterized by shifting demands for workers as some defense production tapers off and civilian production responds to changing consumer demand. Then, too, the demand for labor will not always arise where there is an available supply, so that in some areas extra workers will have to be recruited to augment the local labor force.

As has already been noted, the armed forces constitute one of the principal claimants for manpower. Obviously, the determination of the size and composition of the armed forces and the manner in which those requirements are met have an important bearing on civilian manpower resources and needs.

Policies governing the recall to duty of Reservists and induction of men through the Selective Service System must continue to aim at meeting military manpower requirements without unduly disrupting the activities which support our military strength.

"We must insure that, at the height of the defense program, industry will not find itself depleted of key workers because of military induction and that the armed forces will not find themselves unable to utilize the Reserves they have trained because they are needed in industry."

We must insure that, at the height of the defense program, industry will not find itself depleted of key workers because of military induction and that the armed forces will not find themselves unable to utilize the Reserves they have trained because they are needed in industry.

This means that critical skills must be fully utilized, both in defense industry and in the military, and that recall and induction objectives must not prevent a steady flow of new workers into critical occupations and key professions in order that we may maintain and increase qualitative advantages over our potential foes.

Information Furnished

Toward this end current information concerning critical occupational shortages is furnished to the armed forces and the Selective Service System for guidance in deferring recall of Reservists and deferment of college students and apprentices.

A word should also be said about the concern of the production and procurement agencies with manpower problems. Obviously, if production is to be completed on time it must be scheduled within the limits of what is possible in terms of production facilities, materials, and manpower. Moreover, the manner in which procurement is distributed across the country determines, in large part, the degree to which maximum utilization of available manpower can be achieved.

Other Factors

Likewise, housing, community facilities, and related factors must be taken into account because they condition the extent to which manpower can be most effectively used for defense production.

National manpower policies therefore, have established the principle that available labor supply should be utilized to the fullest extent possible before additional employment requirements are created in areas of labor stringency—in other words, bringing the work to the worker to avoid needless migration, excessive strains on community facilities, and loss of efficiency in defense production.

Collaboration

Another major principle of civilian manpower administration is collaboration by Government with labor and management through national, regional, and area labor-management committees in the development of manpower policies and programs. Only through such active coöperation can the civilian manpower resources be successfully mobilized on a voluntary basis and full weight be given to human considerations, which are just as important as the labor market and occupational characteristics.

Of equal importance is the principle of making maximum use of our available labor supply to relieve manpower shortages in critical occupations through improved techniques and programs of training and utilization and to stimulate the entrance of more potentially qualified workers into critical occupations. While it is recognized that primary responsibility for training rests with management, assistance is being provided employers in installing training programs suited to their individual

needs. Assistance is also made available in developing training courses for scientific, technical, managerial, and highly skilled occupations through use of college and technical school facilities and apprenticeship programs.

Solution Local

Although sound national manpower policies and programs are highly important, the solution to practically all manpower problems must be found where they actually occur—in the thousands of communities across the country. National policies and programs only clear the way for local community leaders, labor, and management groups, Federal, State, and local agencies to solve the manpower problems peculiar to their own communities.

In short, the center of manpower administration is and must remain in the plants, union halls, and public employment offices—in the planning and action of responsible agencies and community groups throughout the Nation.

The local United States Employment Service office is the operating manpower agency within each of the 1,800 communities where it is located. While these offices cannot do the whole manpower job, they provide manpower information, placement, and related technical services to assist employers and workers in making more informed and intelligent employment decisions.

All the vast resources and experiences of the public employment service system are being directed toward meeting the needs of employers engaged in defense work. Preferential service is given these establishments whenever local labor supplies are insufficient to meet over-all needs.

Services Provided

To avoid undue disruption of the labor market and needless in-migration and to facilitate orderly recruitment, personnel people should consult with the local Employment Service office regarding hiring needs. Most of these offices can be particularly helpful in the anticipation and identification of manpower problems and are generally equipped to provide the following services over and above the commonly known recruitment functions:

1. Locate workers with specialized skills in other areas, if they are not available locally, through a nationwide labor-clearance system. Arrangements can be made through local offices for recruitment itineraries in such areas, if so desired.

2. Provide information concerning local, area, and national labor-market conditions, on an occupational basis, particularly in labor surplus or shortage areas.

3. Develop coöperative testing programs for the selection of entry workers and trainees.

4. Determine physical requirements of jobs suitable for employment of the physically handicapped.

5. Assist in alleviating problems of turnover and absenteeism.

6. Suggest in-plant manpower planning methods to effect maximum utilization of employed workers through:

a. The preparation of job inventories from which labor needs can be determined.

b. The conversion and standardization of plant job titles which will facilitate comparison of plant manpower needs with community and national supply data.

c. The inventorying of work-force skills.

d. The determination of relationships between jobs for effective transfer purposes.

Manpower Liaison

Of special interest to those concerned with ordnance procurement and production is the manpower liaison relationship which has been maintained between the USES and the Ordnance Corps since the inception of the defense mobilization program.

Recognizing the magnitude and diversity of Ordnance procurement and its impact on the labor force, the two agencies have established close working relationships at all levels designed to prevent serious manpower difficulties and to effect prompt alleviation in the interest of uninterrupted production of ordnance material.

Furthermore, as a means of achieving more economical procurement, both agencies have coöperated in promoting more efficient personnel practices by Ordnance contractors to assure maximum utilization of the work force. The desired coördination is being achieved through the exchange and pooling of manpower information as a guide to procurement planning, contract administration, and related manpower activities, and provides for prompt higher-level action in the event that a serious manpower problem cannot be solved locally.

Effective Use Important

With substantially full employment and in view of the occupational shortages previously mentioned, it is incumbent on employers to assure that they make the most effective use of their individual labor forces.

This means that they must keep informed of the changing character of the labor market and introduce, as soon as practicable, such modifications in hiring specifications as changes in the labor market justify. If they have not already done so, personnel supervisors should take complete inventory of the abilities of all workers on the job and make sure that they are working at their possible highest skills.

Changing products and processes suggest increased attention to maintaining a flow of 2-way communication between supervisors and employees so that management keeps informed of employee attitudes and facilitates employee cooperation in effecting the required changes with a minimum of absenteeism and turnover.

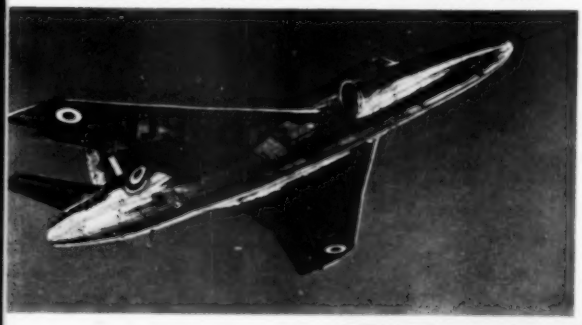
Expansion of the work force or major readjustments in production requirements also frequently pose special problems of orientation and on-the-job training and may involve upgrading workers or simplifying job processes.

Assistance Offered

The public employment service can provide information about the labor market, can assist in the recruitment of workers, and suggest techniques for improved manpower utilization. But the effective use of the employed labor force can result only from the actions of thousands of establishments using their labor force in such a way as to achieve the national mobilization goals.

New British Aircraft

Descendant of the famous Spitfire, the Vickers Supermarine Swift shown both above and below, is powered by two Rolls-Royce "Avon" jet engines and can fly well over 670 m.p.h.



Shown on this page are just a few of the many outstanding jet planes now being developed by the British Air Force. Some of these new types may be used to bolster the air strength of the NATO countries for which Britain was scheduled to build 1,300 planes.

The Hawker Sea Hawk, first British folding-wing jet interceptor, right, is tested aboard the new carrier, EAGLE, specially designed to operate modern jet aircraft.

Powered by four Rolls-Royce axial-flow turbojets, the Avro 698, below, is Britain's newest heavy delta-wing jet bomber.

Below, the Javelin all-weather delta-wing fighter, now in production for the British Air Force.

Month by Month: Highlights of the National Defense

As announced elsewhere in this issue, the American Ordnance Association starts its thirty-fifth year of service to our national defense under the leadership of an outstanding group of men who comprise its board of directors and its officers.

All are individuals of the highest civic attainments and many of them have records of lasting achievement in our armed forces.

In this place we record some highlights of the activities of those recently elected in order that all members of the Ordnance Association may be reminded of the high caliber of these volunteers who are willing to give of their time and talents to the performance of the Association's important mission for our national defense.

The president of the American Ordnance Association for the two-year period beginning January 1, 1953, is Lieut. Gen. Levin H. Campbell, distinguished Chief of Ordnance during the Second World War, who has had wide acquaintance throughout the armed service and American industry. He is chairman of the Automotive Safety Foundation and a member of the boards of directors of several leading companies, including American Steel Foundries and Curtiss-Wright Corporation. He has served as a director of the American Ordnance Association since 1948 and was recently elected a director for another 4-year term ending December 31, 1956.

General Campbell was born in the District of Columbia and was graduated from the United States Naval Academy, Class of 1909. He transferred to the Army and was commissioned a second lieutenant of Coast Artillery in 1911. He was promoted through grades to lieutenant general in 1945.

As a career officer of the Regular Army he filled many posts of great responsibility, notably at the Rock Island and Frankford Arsenals, and early in the Second World War was in charge of the construction and operation of the vast program of new ordnance plants which were built throughout the country and operated by private industry. Subsequently he became director of production for the Ordnance Department, which responsibility he held at the time of his appointment to head the Department in 1942.

Following his retirement from active military service in 1946, General Campbell became executive vice-president of International Harvester Company, Chicago, which important assignment he relinquished last year to become chairman of the board of the Automotive Safety Foundation.

General Campbell has received the following awards: Distinguished Service Medal with Oak Leaf Cluster (Army); Distinguished Service Medal (Navy); Cross of the French Legion of Honor (Officer); Knight Commander Most Excellent Order of the British Empire. In 1944 he was awarded the Crozier Gold Medal, highest award of the American Ordnance Association, which was founded in memory of the late Maj. Gen. William Crozier, distinguished Chief of Ordnance of the Army, 1901-1918. General Campbell was also awarded the Charles L. Harrison Gold Medal by the Cincinnati Post, A.O.A., and the John C. Jones Gold Medal by the Philadelphia Post, A.O.A.

As president of the American Ordnance Association General Campbell succeeds his friend and associate of many years, the late Col. James L. Walsh. Since the death of Colonel Walsh, June 11, 1952, the office of president of the Association has remained vacant in tribute to his memory.

During this period the duties of the presidency were performed by the Association's senior vice-president, Col. Herbert A. Gidney, who has long been identified with the direction of Ordnance affairs, first as an official of the Association's Pittsburgh Post and later as a national officer. Colonel Gidney was assisted by members of the Executive Committee, especially by Harvey C. Knowles, also a vice-president of the Association and vice-president of Procter & Gamble Company, Cincinnati, Ohio. Both Colonel Gidney and Mr. Knowles continue to serve as vice-presidents and as directors.

Adm. W. H. P. Blandy was elected a vice-president of the Association in addition to the incumbent vice-presidents who were reëlected. The by-laws of the Association were amended in order that this special honor might be accorded Admiral Blandy in tribute to his renowned leadership in all matters connected with ordnance progress.

William Henry Purnell Blandy is one of the outstanding officers of the United States Navy. He was educated at the University of Delaware and was graduated from the United States Naval Academy, Class of 1913. He advanced through the grades from ensign in 1913 to admiral in 1947.

He was Chief of the Bureau of Ordnance, Navy Department, 1941-1943; Commander of Amphibious Group One in the Pacific, 1944-1945; and participated in the capture of Kwajalein, Saipan, Palau, Iwo Jima, and Okinawa.

Later he was commander of cruisers and destroyers of the Pacific Fleet and subsequently Deputy Chief of Naval Operations for Special Weapons during which period as commander of Joint Army-Navy Task Force One he planned and commanded the atomic-bomb tests at Bikini. At the time of his retirement from active naval service he was Commander in Chief of the Atlantic Fleet. He is currently president of the Health Information Foundation with headquarters in New York City.

Admiral Blandy wears the Distinguished Service Medal with three Gold

Stars; Grand Officer, Order of the Southern Cross (Brazil); and Commander of the Order of the British Empire. In 1944 he was awarded the American Ordnance Association's Scott Gold Medal for Distinguished Ordnance Service. In 1950 the Association's Cincinnati Post similarly honored him with its Charles L. Harrison Gold Medal.

In addition to General Campbell and Admiral Blandy the following directors were elected for terms of four years:

K. T. Keller, Director of Guided Missiles, Department of Defense, and chairman of the board of the Chrysler Corporation, Detroit, has long held leadership in the industrial and defense councils of our country. He has built and operated some of the Nation's largest ordnance production establishments, notably the tank arsenals at Detroit and Newark, Del.

Following his education at Mount Joy and Lancaster in his native Pennsylvania he began as a machine-shop apprentice with the Westinghouse Electric and Manufacturing Company in 1906, later becoming assistant superintendent of the automobile engine department. He became associated with General Motors Corporation in 1911, advancing to the vice-presidency of the Chevrolet Motor Company and, later, general manager of Canadian operations for that corporation.

He has served with the Chrysler Corporation since 1926, first as vice-president in charge of manufacturing, subsequently as president, and currently as chairman of the board.

The Chrysler Detroit Tank Arsenal, which was built and operated under the direction of Mr. Keller during the Second World War, and now the Chrysler Delaware Tank Plant at Newark, Del., are tributes to his deep loyalty to ordnance as well as to his outstanding industrial and engineering leadership.

In 1947 he was awarded the Charles L. Harrison Gold Medal and in 1949 the Association's Crozier Gold Medal, both for distinguished ordnance service.

C. Jared Ingersoll, also elected a director, is a well-known railroad official, a native Philadelphian, who served as chief of the Philadelphia Ordnance District during the Second World War. He is chairman of the board of the Kansas, Oklahoma and Gulf Railroad, an official of a number of other railroads of the Midwest, and a director of the Pennsylvania Railroad. He is a director of Phelps Dodge Corporation, the Insurance Company of North America, and the Atlantic Refining Company.

Following his education at Princeton University he served as a lieutenant in the United States Navy in the First World War.

For his successful direction of the Philadelphia Ordnance District during the Second World War he was awarded the Medal for Merit.

He was also awarded the John C. Jones Gold Medal of the Philadelphia Post, American Ordnance Association, for distinguished ordnance service.

Charles D. Wiman, a director of the Association, is known for his leadership in the field of manufacturing agricultural implements. Since 1929 he has served as president of Deere & Company, Moline, Ill., with which organization he first became connected in 1915.

During the First World War he served overseas as a captain of Field Artillery. In the Second World War he served in the Ordnance Department of the Army with the rank of colonel on special assignments connected with the efficient utilization of manpower.

A graduate of Yale University, he is identified with a number of leading financial and industrial organizations, being a director of the Moline National Bank, Continental Illinois National Bank and Trust Company, the Protection Mutual Fire Insurance Company, and the Illinois Manufacturers Association. For his service to the Ordnance Department in the Second World War he was awarded the Legion of Merit.

The directors mentioned above are in addition to the following previously elected members of the board:

R. L. Biggers, president, Fargo Division, Chrysler Corporation, Detroit, Mich.;

Donald F. Carpenter, Wilmington, Del.;

Henry L. Clark, General Motors Corporation, South Gate, Calif.;

William W. Coleman, chairman, Bucyrus-Erie Company, Milwaukee, Wis.;

C. Stewart Comeaux, Coronado, Oklawaha, Fla.;

Henry P. Erwin, director, Riggs National Bank, Washington, D. C.;

B. F. Fairless, chairman, U. S. Steel Corporation, Pittsburgh, Pa.;

R. E. Gillmor, Sperry Corporation, New York, N. Y.;

E. R. Godfrey, vice-president, General Motors Corporation, Detroit, Mich.;

Ben Morcell, president, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.;

Frederick H. Payne, Springfield, Mass.;

Louis Polk, president, Sheffield Corporation, Dayton, Ohio;

John Slezak, president, Turner Brass Works, Sycamore, Ill.;

J. E. Trainer, vice-president, Firestone Tire & Rubber Company, Akron, Ohio.

Reëlected vice-presidents were Herbert A. Gidney, Harvey C. Knowles, Robert L. Biggers, Louis Polk, Daniel J. Martin, and John S. Pfeil. Colonel Martin is vice-president for research, Hughes Tool Company, Houston, Tex., and Colonel Pfeil is vice-president, Stone & Webster, Inc., Boston, Mass.

Brig. Gen. John Ross Delafield, distinguished attorney of New York, was reëlected counsel of the Association, Colonel Erwin was reëlected treasurer, Leo A. Codd, Washington, D. C., executive vice-president, and Florence G. Ferriter, Washington, D. C., secretary.

Photographs of the above directors and elected officers are on the following pages.

The election of officers was held at the annual meeting of the Board of Directors in New York City on December 3, 1952.

Officers and Directors of the

Lieut. Gen. Levin H. Campbell, Chief of Ordnance of the Army during the Second World War, was elected president of the American Ordnance Association for a term of two years beginning January 1, 1953. The election was held at the annual meeting of the Board of Directors in New York City, December 3, 1952.

General Campbell succeeds the late Col. James L. Walsh who had held the office with distinction since 1947.

The Board also elected Adm. W. H. P. Blandy, one of the Navy's most distinguished officers, a vice-president of the Association.

Levin H. Campbell
President, Washington, D. C.

Herbert A. Gidney
Vice-President, Ft. Lauderdale, Fla.

Harvey C. Knowles
Vice-President, Cincinnati, Ohio

R. L. Biggers
Vice-President, Detroit, Mich.

K. T. Keller
Director, Detroit, Mich.

W. W. Coleman
Director, Milwaukee, Wis.

Frederick H. Payne
Director, Springfield, Mass.

J. E. Trainer
Director, Akron, Ohio

Henry P. Erwin
Treasurer, Washington, D. C.

Donald F. Carpenter
Director, Wilmington, Del.

Charles D. Wiman
Director, Moline, Ill.

Henry L. Clark
Director, Los Angeles, Calif.

American Ordnance Association

Admiral Blandy was Chief of the Bureau of Ordnance early in the Second World War and later served in a number of historic engagements in the Pacific. At the time of his retirement from active service he was Commander in Chief of the Atlantic Fleet.

Other directors elected in addition to General Campbell and Admiral Blandy were K. T. Keller, chairman, Chrysler Corporation, Detroit; C. Jared Ingersoll, railroad executive, Philadelphia, Pa.; and Charles D. Wiman, Deere & Company, Moline, Ill. Photographs of these and other officers and directors of the Association appear on these pages.

Louis Polk
Vice-President, Dayton, Ohio

W. H. P. Blandy
Vice-President, New York, N. Y.

Daniel J. Martin
Vice-President, Houston, Tex.

John S. Pfeil
Vice-President, Boston, Mass.

R. E. Gillmor
Director, New York, N. Y.

John Slezak
Director, Chicago, Ill.

C. Jared Ingersoll
Director, Philadelphia, Pa.

Edward R. Godfrey
Director, Detroit, Mich.

C. Stewart Comeaux
Director, Ohlawaha, Fla.

B. F. Fairless
Director, Pittsburgh, Pa.

Ben Moreell
Director, Pittsburgh, Pa.

John Ross Delafield
Counsel, New York, N. Y.

ASSOCIATION AFFAIRS

• **AT ROCK ISLAND.**—One hundred and five members of the Quad Cities-Iowa Post attended the October 1952 meeting at the Rock Island Arsenal. G. L. Weissenburger, president of the Post, presided. The guests were welcomed by Col. W. W. Warner, commanding officer at Rock Island. He described for those present the operation of the Management School at the arsenal, the function of which is to instruct personnel of Army Ordnance in basic processes of good management.

Preceding the arsenal session, the members of the Post were the guests of the Bendix Aviation Corporation and toured the Pioneer Central Division plant where aviation instruments of highest precision are produced.

Robert L. Wannamaker, systems development engineer of General Electric Company, Schenectady, representing the Aircraft Industries Association of America, was the guest speaker. His lecture dealt with electronic problems connected with automatic flight control of airplanes and guided missiles. These controls govern the stability of aircraft in pitch, roll, and yaw. The talk was illustrated by slides descriptive of the development of these control devices.

Mr. Wannamaker described how block diagrams are initially drawn and mathematical expressions derived which are based upon the application, design, and speed. These are then initially developed in the form of "bread-board" models which are tested in the laboratory with simulated flutter and roll condition signals being impressed on the tentative circuits by means of electronic impulse units, based upon computations derived from the original block diagram equations.

These models are developed experimentally to the point where it is feasible to construct actual working units for test. At this point they are installed in an actual aircraft or guided missile and then thoroughly tested.

In the aircraft phase it is possible to make corrections during flight, but with guided missiles this is not possible. For this reason, it is imperative that calculations and tests be thoroughly checked prior to the final stage of application so as to reduce as far as possible the enormous expense connected with this phase of testing.

• **AT LAFAYETTE.**—At Purdue University, a meeting of the Ordnance Club was held on October 29, 1952, with Neil Bean, president of the club, presiding. Col. T. E. Carney, assistant professor of military science and tactics, who is in charge of the Ordnance R.O.T.C. Unit at Purdue, has sponsored the club from its inception, and under his direction it has grown to be an important part of campus activity at the university. Col. Ferdinand B. Porter, professor of military science and tactics at Purdue, was present at the meeting.

A colored moving-picture film of the Thirty-third Annual Meeting of the Ordnance Association at Wright-Patterson Air Force Base was shown, following which the members heard an address on the place of the Ordnance engineer in future needs of our national defense. The address was by Leo A. Codd, executive vice-president of the A.O.A., Washington, D. C.

• **AT CINCINNATI.**—Charles E. Wilson, former Director of Defense Mobilization and former president of the General Electric Company, was awarded the Charles L. Harrison Gold Medal for Distinguished Ordnance Service on October 30, 1952. More than 800 members and guests were in attendance to honor Mr. Wilson and to hear his address which is published in full beginning on page 594 of this issue.

The dinner meeting was held in the grand ballroom of the Netherland-Plaza Hotel. Harold R. LeBlond, president of the Post and president of the Cleveland Automatic Machine Company, was toastmaster.

Present as guests of the Association were the district chiefs, deputy chiefs, arsenal and center commanders of Army Ordnance, led by Maj. Gen. E. L. Ford, Chief of Ordnance, who also addressed the meeting. (His address is published in full as an article in this issue on page 602.) These representatives of Army Ordnance held their quarterly conference at Cincinnati, October 30th to November 1st.

Preceding Mr. Wilson's address the Harrison Medal was presented on behalf of the Post by the Committee on Award. The citation accompanying the medal (see page 595 of this issue) was read by Frederick V. Geier, a director of the Post and president of the Cincinnati Milling Machine Company.

The medal was presented by Harvey C. Knowles, also a director of the Post, a vice-president of the American Ordnance Association, and vice-president of Procter & Gamble Company, Cincinnati.

General arrangements for the meeting were in charge of Col. O. P. Winningstad, secretary of the Post, and a distinguished Army Ordnance officer who has participated in many important ordnance operations at home and abroad.

Next day, a number of those present journeyed to Dayton, Ohio, to witness the formal presentation of the fully automatic 90-mm. complete-round gage developed for Army Ordnance by the Sheffield Corporation. This is the largest gage ever produced. Guests were given an opportunity to inspect this ingenious machine which performs the external gaging operations on a complete round of 90-mm. artillery ammunition.

In the party were General Ford and Maj. Gen. E. L. Cummings, chief of the Ordnance Industrial Division, and Maj. Gen. L. E. Simon, chief of the Ordnance Research and Development Division.

The several hundred members and guests who witnessed the demonstration of the new gage were greatly impressed by the speed and accuracy with which it performed the many heretofore time-consuming separate operations.

• **AT SYRACUSE.**—The annual meeting of the Empire Post was held November 18, 1952, in the grand ballroom of the Hotel Syracuse with Rear Adm. Malcolm M. Schoeffel, Chief, Bureau of Ordnance, United States Navy, as honor guest and principal speaker.

More than 500 members and guests were present to hear the admiral's address on "The Modern Navy and Its Firepower." The toastmaster was Carl S. Hallauer, president of the Empire Post and vice-president of Bausch & Lomb Optical Company, Rochester.

Greetings were extended by the following: From the community, Hon. Thomas J. Corcoran, Mayor, City of Syracuse; from the Congress, Hon. R. Walter Riehlman, Representative in Congress, 36th District; from New York State industry, Martin F. Hilfinger, president, Associated Industries of New York State;

Louis Polk, left, president, Sheffield Corporation, Dayton, Ohio, explains the new 90-mm. complete-round gage to Maj. Gen. E. L. Ford, Chief of Army Ordnance; Maj. Gen. E. L. Cummings, head of the Ordnance Industrial Division; Maj. Gen. L. E. Simon, chief of the Ordnance Research and Development Division; and Brig. Gen. W. P. Farnsworth, Wright-Patterson AFB, Dayton.

from the Army, Col. Henry R. Westphalinger, U.S.A., deputy chief, Rochester Army Ordnance District; from the Air Force, Brig. Gen. Richard C. Lindsay, commanding Sampson Air Force Base; from the American Ordnance Association, Leo A. Codd, executive vice-president, A.O.A.

Admiral Schoeffel, using slides and moving pictures, described many of the new advances in the field of naval ordnance development and stressed the important place of private industry in the perfection of the new devices.

Seated with him at the speakers' table, in addition to those previously named, were: John L. Collins, assistant general manager, New Process Gear Corporation; Maj. Leslie J. Parnell, U.S.M.C., instructor, 2nd Tank Battalion, U.S.M.C.R.; Charles D. Osborne, *Auburn Citizen-Advertiser*, vice-chairman, Syracuse-Central New York Chapter; Ray C. Malvin, manager, U. S. Hoffman Machinery Corporation, Auburn, chairman, Syracuse-Central New York Chapter; Francis R. Gorman, Halpern & Gorman, Utica, chairman, Mohawk Valley Chapter; Comdr. A. W. Czehatowski, U.S.N., inspector of naval material;

Also Keith Williams, president, Pratt & Letchworth Company, Buffalo, first vice-president, Empire Post; Rev. Dr. John A. Whitesel, coördinating chaplain, Protestant Social Service Bureau, Council of Churches of Syracuse and Onondaga County; John T. Schenck, president, Engelberg Huller Company, chairman, board of directors, Manufacturing Association of Syracuse; Raymond M. Biehler, Rochester Institute of Technology, treasurer, Empire Post; Stanley H. Ellison, executive assistant, Carrier Corporation, meeting chairman, Syracuse-Central New York Chapter; Maj. Joseph N. Fournier, senior unit instructor, Organized Reserve Corps;

Also C. Earl Norquist, president, Norquist Products, Inc., Jamestown, chairman, Jamestown Chapter; Lieut. Comdr. H. B. Pence, U.S.N.R., commanding officer, Naval Reserve Unit, Syracuse; John D. Williams, vice-president, Lipe-Rollway Corporation, cochairman, Nominating Committee, Syracuse-Central New York Chapter; and Capt. E. Gwyn Thomas, secretary of the same chapter.

Arrangements for the meeting were under the capable direction of Captain Thomas who, in addition to being public relations director of the Manufacturers' Association of Syracuse, is an Army Ordnance Reserve officer of wide acquaintance. He served in the Rochester Ordnance District during the Second World War and is known throughout industry of upstate New York.

• **AT HOUSTON.**—A general meeting of the Texas Post was held at the Officers' Club, Ellington Air Force Base, on December 2, 1952. The principal speaker was Col. F. S. Bryan, deputy chief of the St. Louis Army Ordnance District.

Formerly deputy chief of the Philadelphia Army Ordnance District, Colonel Bryan gave to the 110 Post members present an insight into the operations of the district office which covers parts of seven States with regional offices in Houston, Dallas, Tulsa, Denver, and Kansas City.

During a question-and-answer period which followed, Colonel Bryan discussed many of the detailed policies regarding the operations of the Ordnance districts.

At the election of officers held at the meeting the following were elected: W. O. Hedrick, McEvoy Company, president; W. H. Miner, Lufkin Foundry & Machine Company, vice-president; Leo S. Bassett, Dickson Gun Plant—Ordnance, secretary-treasurer. *(Continued on p. 640)*

Presidents of Local Posts of the

Bradford C. Colcord
Birmingham Post

E. E. Johnson
Capital Cities Post

James R. Munro
Central Illinois Post

John Slezak
Chicago Post

Carl S. Hallauer
Empire Post

Lieut. Col. R. L. Dickson
Florida Post

Stanley C. Hope
Hartford-Springfield Post

C. E. Medley
Lone Star Post

Harry Darby
Midwest Post

Frederick D. Hansen
Milwaukee Post

Ben H. Hughes
Nebraska Post

George F. Hussey, Jr.
New York Post

G. L. Weissenburger
Quad Cities-Iowa Post

Col. Henry E. Minton
Rio Grande Post

James D. Maitland
Rocky Mountain Post

G. A. Waters
St. Louis Post

Association

The Local Posts of the American Ordnance Association, located in thirty-five industrial, scientific, and educational centers throughout the United States, are a vital factor in the Association's task of fostering industrial preparedness.

These Posts by their meetings, seminars, plant visits, and similar activities keep alive an interest in the continuing need for scientific and industrial know-how in the production of the weapons of defense. The presidents of these Posts, most of whom are shown below, are the key men in this nationwide effort for peace.

Harold R. LeBlond
Cincinnati Post

W. L. Yarborough
The Citadel Post

Albert J. Weatherhead, Jr.
Cleveland Post

Byron J. Beattie
Columbia River Post

W. A. Wilson
Los Angeles Post

N. L. Hawkins
Louisiana Post

Robert L. Biggers
Michigan Post

M. H. Johnson
Mid-Continent Post

W. C. MacFarlane, Sr.
Northwest Post

Albert W. Gilmer
Philadelphia Post

Col. Thomas H. Eddy
Pittsburgh Post

Murray Aitken
Puget Sound Post

Edgar B. Jessup
San Francisco Post

Brig. Gen. E. D. Konken
Texas Post

Ludlow King
Washington Post

Harry A. Wansker
Yankee Post

The following directors also were elected: Phillip P. Krumb, Sr., Rheem Manufacturing Company; M. I. Kearns, Brown & Root, Inc.; Maj. R. D. Springer, St. Louis Ordnance District; D. J. Martin, Hughes Tool Company; O. L. Lorchn, Cameron Iron Works; and K. P. Campbell, Sheffield Steel Corporation.

• **AT M.I.T.**—The annual election of officers of the Massachusetts Institute of Technology Post was held at M.I.T., December 3, 1952. The following were elected:

Stanley A. Hoff, M.I.T., president; Ernest P. Abrahamson, II, M.I.T., vice-president; Robert H. Tucker, Cambridge, Mass., secretary-treasurer.

The Post has the enthusiastic support and help of Lieut. Col. Samuel L. Hall, Ordnance Corps, U. S. Army, assistant professor of military science and tactics at the institute.

• **AT WASHINGTON.**—A large and representative group of members of the Washington Post attended the November 20, 1952, luncheon at the South American Room, Hotel Statler, to honor J. E. Trainer, vice-president of the Firestone Tire & Rubber Company, Akron, who presented a paper on "The Rubber Industry as an Ordnance Supplier." (Mr. Trainer's address is published in full as an article beginning on page 615 of this issue.)

Presiding at the luncheon meeting was Ludlow King, president of the Post. In attendance was a widespread representation of military officials as well as officials from other governmental agencies. The meeting was under the direction of W. J. Sears, secretary-treasurer of the Post.

Mr. Trainer, who is also a national director of the American Ordnance Association as well as a director of the Cleveland Post, is in charge of worldwide production activities of the Firestone Company. In the Second World War he was cited by the Secretary of the Army for his managerial and administrative services rendered personally to the Chief of Ordnance.

Other officers of the Washington Post are: J. Donald Browne and Fred T. Marshall, vice-presidents; and the following directors: C. E. Meissner, Brig. Gen. Merle H. Davis, Stanley A. Shank, George M. Riveire, W. G. Lockwood, Dr. A. V. Astin, Dr. A. F. MacConochie, C. H. M. Roberts, George E. Engelmann, T. J. McCloskey, H. N. Arbuthnot, and A. H. Hobelmann.

• **AT BIRMINGHAM.**—The thirty-third annual meeting of the Birmingham Post, with Maj. Gen. Emerson L. Cummings, Assistant Chief of Ordnance of the Army, as principal speaker, was held at the Birmingham Country Club, December 12, 1952. Nearly 300 members—the capacity of the ballroom—were in attendance to hear General Cummings who delivered a timely and informative address on the status of ordnance progress during the past year. (General Cummings' address will be published in full as an article in the next issue of this magazine.)

Bradford C. Colcord, newly elected president of the Post, was toastmaster at the dinner. Mr. Colcord is president of the Woodward Iron Company. Col. William J. Rushton, chief of the Birmingham Army Ordnance District and president of the Protective Life Insurance Company, introduced General Cummings.

Preceding the dinner meeting an inspection tour was arranged for members and guests of the Post to the Line Material Company and the Hayes Aircraft Corporation plants. Line Material Company is engaged in the manufacture of rifle barrels for the Army. It is the first Southern firm to be engaged in small-arms manufacture of major consequence since 1832 when such production was carried forward by James Bowie in Natchez, Miss., and a few other rifle makers in New Orleans and Kentucky.

Hayes Aircraft Corporation is currently engaged in the modification of B-25 type aircraft for the United States Air Force. Chartered buses left the Tutwiler Hotel at 1 P.M. for the inspection tour, returning at 4:30.

Incident to the dinner meeting was an ordnance display at the Country Club where many samples of ordnance matériel produced in the Birmingham Army Ordnance District were on view.

General Cummings was educated at West Point, Cornell University, and Massachusetts Institute of Technology and has a long background of engineering and ordnance experience. Presently chief of the Industrial Division, Office, Chief of Ordnance, United States Army, General Cummings is responsible for procurement and production of ordnance material and equipment for the Army. The general has performed field engineering duties in Alaska and Fort Lewis, Washington, and served as chief of Industrial Division, European Theater, in Paris, France, and Frankfort, Germany.

In 1948 he returned to the United States to enter the National War College from which he was graduated. In September 1950 he received assignment to his present position.

Other speakers included Colonel Rushton and Leo A. Codd, executive vice-president of the American Ordnance Association.

Following the addresses a business meeting was held at which the following officers of the Post were elected: President, Bradford C. Colcord, Woodward Iron Company, Birmingham, Ala.; vice-president, A. V. Wiebel, Tennessee Coal and Iron Division, U. S. Steel Corporation, Fairfield, Ala.; treasurer, Robert D. Cotten, Protective Life Insurance Company, Birmingham, Ala.; and secretary, Ralph E. Parker, Birmingham, Ala..

The following have also been chosen directors of the Post: James M. Barry, Southern Company, Birmingham, Ala; J. L. Bedsole, Williams Box Company, Prichard, Ala.; D. W. Blend, Wolverine Tube Division, Decatur, Ala.; R. H. LeTourneau, R. G. LeTourneau Company, Vicksburg, Miss.; R. S. Lynch, Atlantic Steel Company, Atlanta, Ga.; W. H. Martin, Jr., King Stove & Range Company, Sheffield, Ala;

Also S. D. Moxley, American Cast Iron Pipe Company, Birmingham, Ala.; C. Pratt Rather, Southern Natural Gas Company, Birmingham, Ala.; F. O. Reemer, Pullman-Standard Car Manufacturing Company, Birmingham, Ala.; Walker Reynolds, Alabama Pipe Company, Anniston, Ala.; William J. Rushton, Birmingham Ordnance District, Birmingham, Ala.; L. N. Shannon, Stockham Valves & Fittings, Birmingham, Ala.

• **AT WATERVLIET.**—The first meeting of the 1952-1953 season of Capital Cities Post was held at Circle Inn, Lathams, N. Y., November 13, 1952. Dr. W. R. G. Baker, general manager of the Electronics Division and vice-president of the General Electric Company, who recently returned from a military mission to the front lines in Korea, spoke on "Mission to Korea." He reported that troop morale is high and that many of our soldiers in Korea are professional fighting men ready to meet the challenge before them.

Doctor Baker, for whom General Electric's Schenectady television outlet is named, was one of eight Americans, including four scientists, who went to Korea to study ways of increasing the combat effectiveness of the American soldier and his supporting organizations. The General Electric scientist disclosed that thirty recommendations were submitted to the Government upon completion of the 20,000-mile air trip.

Doctor Baker used films taken on the trip showing not only military conditions in Korea but glimpses of civilian life in that country, Japan, and other countries along the way. He reported that mortar fire is causing a major proportion of the injuries among our troops in Korea and that artillery barrages on both sides are "terrific."

E. E. Johnson, president of the Post, presided at the dinner meeting and announced the officers elected for 1953, as

Some of the 220 members of the Los Angeles Post who took part in a cruise and demonstration aboard the U.S.S. ROCHESTER.

follows: Col. R. Z. Crane and Brig. Gen. Wendell Westover, vice-presidents; E. S. Webster, secretary-treasurer; J. E. N. Hume, Sr., H. G. Batcheller, A. H. Maggs, and General Westover, directors with terms expiring April 30, 1953; Mr. Johnson, Colonel Crane, L. Cogswell, Jr., and L. W. Dwyer, directors with terms expiring April 30, 1954; and J. O. Amstuz, W. A. Kitts, H. L. Erlicher, and Ray Stearns, directors with terms expiring April 30, 1955.

The following committees of the Post are actively at work: Membership, Mr. Stearns, chairman; Industrial Preparedness, Mr. Amstuz, chairman; Student Activities, Prof. A. A. K. Booth, chairman; Programs and Meetings, W. C. Elcan, chairman; Technical Progress, Col. H. H. Zornig, chairman.

• **AT LOS ANGELES.**—On October 25, 1952, a field trip for members of the Los Angeles Post highlighted the importance of armament in our naval progress. Two hundred and twenty members of the Post boarded the U.S.S. ROCHESTER at 10 A.M. at Long Beach. The cruiser cleared the harbor, and at rendezvous with the destroyer escort CURRIER refueling operations were demonstrated.

Luncheon was served aboard the ROCHESTER, following which target practice with 40-mm. guns at radio-controlled drone planes was scheduled. This was followed by a conducted tour of the ship which returned to dock at 3:30 P.M. Navy hospitality and efficiency were in evidence on all sides.

The meeting was under the auspices of William A. Wilson, president of the Post, assisted by other officers and directors including: R. C. Geffs, vice-president; C. H. Nazro, secretary; Samuel K. Rindge, treasurer; and the following directors: Henry L. Clark, F. W. Conant, Louis G. Dunn, P. W. Lizza, Walter C. Main, J. P. McCafferty, K. T. Norris, Morris B. Pendleton, John B. Rauen, J. D. Spalding, and C. B. Tibbetts.

Particular thanks were extended to the following officers of the Navy for their participation in this most instructive tour: Adm. H. G. Hopwood, Commander, Cruisers and Destroyers, Pacific Fleet; Adm. C. L. C. Atkeson, Commander, Destroyer Flotilla; Capt. R. H. Phillips, commanding officer of the ROCHESTER; Comdr. D. N. Clay, the executive officer; and Comdr. D. M. Armstrong, operations officer.

• **COL. HENRY P. ERWIN**, treasurer of the American Ordnance Association and, with the late Col. James L. Walsh, founder of this magazine, was honored by the George Washington University at a convocation held in the Lisner Auditorium, Washington, D. C., November 10, 1952, when the honorary degree of doctor of science was conferred upon him.

Colonel Erwin is a member of the board of trustees of the University and Chairman of its finance committee. He is a director of Riggs National Bank, and has served as chairman of the Operating Committee of the United Services Organization Club which functions in the Nation's Capital.

On active service during the First and Second World Wars, he was chief of the Administrative Branch, Technical Division, Office of the Chief of Ordnance during the latter conflict. He has served first as assistant treasurer and, as at present, treasurer of the American Ordnance Association for many years.

In conferring the honorary degree upon Colonel Erwin, Dr. Cloyd H. Marvin, president of the University, read the following citation:

"Henry Parsons Erwin, son of the University of Michigan, the University of Chicago, and the Illinois Institute of Technology, has extended and applied his engineering backgrounds to competent service in business, and to the highest contribution to his Nation through the Ordnance Division of the United States Army. He has served his community without stint by supporting the work of organizations to care for the less fortunate in life, and the youth of the District of Columbia through his devotion to the work of the Boy Scouts of America. He has a strength for righteousness and is warm-hearted toward those with whom he associates himself."

• **COL. G. B. JARRETT**, chief of the Ordnance Museum at Aberdeen Proving Ground, has been appointed honorary curator of the West Point Museum by Maj. Gen. F. A. Irving, superintendent of the United States Military Academy. In a letter written to Colonel Jarrett, General Irving said:

"In recognition of your standing as an authority in the field of modern ordnance and in acknowledgment of your generous activities in an advisory and consultative capacity on behalf of the West Point Museum, it gives me great pleasure to appoint you an honorary curator of the West Point Museum. As a token of appreciation for your proved readiness to proffer such assistance, I ask you to accept the inclosed diploma with my compliments."

General Irving added, "It is a distinction for the Museum that it may welcome you as an 'ex officio' member of its staff, and I trust that you will have no objections to the recording of your name as an honorary curator in appropriate future publications of the Military Academy and the Museum."

Colonel Jarrett is a recognized authority on ordnance matériel in general and foreign ordnance in particular. He has been connected with various museums since he was fifteen years old and had his own museum, "The Jarrett Museum of World War History," for twenty-five years.

Among the wartime citations he received were the Legion of Merit for service in Egypt, the Army Commendation Medal, and the Order of the British Empire for service in Libya during the African Campaign of the Second World War.

• **SECRETARY OF THE NAVY DAN A. KIMBALL**, presented the Distinguished Service Medal at ceremonies in the Pentagon on November 25, 1952, to Rear Adm. Louis L. Strauss, U.S.N.R., a member of Council, American Ordnance Association.

The award was for exceptionally meritorious service as Special Assistant to the Secretary of the Navy, as a member of the Army and Navy Munitions Board, and as a member of the Joint Board of the Postwar Army-Navy Training in Industrial Mobilization.

A former member of the Atomic Energy Commission, Admiral Strauss is currently serving as a member of the Citizens Advisory Commission on Manpower Utilization in the Armed Services. The citation presented to Admiral Strauss reads:

"For exceptionally meritorious service to the Government of the United States in a duty of great responsibility as Special Assistant to the Secretary of the Navy, with additional duty as Navy Member of the Executive Committee of the Joint Army-Navy Munitions Board and as Navy Member of the Joint Board on Postwar Army-Navy Training in Industrial Mobilization from August 1 to November 1, 1944, and from February 1, 1945, to January 2, 1946. Exercising sound judgment and exceptional foresight, Rear Admiral Strauss was in large measure responsible for the efficient functioning of the Army-Navy Munitions Board and played an important rôle in the consideration of the postwar educational system of the services in the field of industrial mobilization, production, and closely related subjects. His outstanding leadership, marked professional skill, and zealous devotion to the fulfillment of these varied and exacting assignments reflect the highest credit upon Rear Admiral Strauss and the United States Naval Service."

• **JUSTIN A. FITZ**, director of advertising and information for the Sperry Gyroscope Company, and a loyal member of the New York Committee, American Ordnance Association, died suddenly on December 9, 1952. Only a week before, he had, as a member of the committee, assisted at the Thirty-fourth Annual Meeting of the Association at the Waldorf-Astoria, New York.

He was well known throughout the Ordnance fraternity for his loyal, efficient, and steadfast attachment to all phases of our national defense, especially those related to the field of ordnance progress.

A native of Everett, Mass., Mr. Fitz served with the Navy in World War I. His experience led to his affiliation with the Sperry organization as a technician on gyrocompasses and other special instruments. He helped to make the first permanent installation of a gyrocompass on a ship on the Great Lakes. He conducted field tests of compasses and other electronic devices on Army tanks and aircraft.

He traveled extensively in this country and abroad in connection with the technical and engineering activities of his company. As director of information, which office he undertook in September 1923, his activities included the writing of technical handbooks, publicity, and, for a number of years, the editing of the Sperry Gyroscope Company publication, *Sperryscope*.

In addition to his membership in the Ordnance Association he was a member of the Institute of the Aëronautical Sciences and the Aircraft Industries Association.

As a member of the New York Committee of the A.O.A., Justin Fitz had for many years assisted at the reception for honor guests and in the general planning of the annual meetings of the Association. His cheerful manner and capable efforts will be greatly missed both by the New York Post and the national Ordnance organization in both of which he took a leading and valued part for many years.

• **JOHN M. STOCKARD**, torpedo engineer in the Bureau of Ordnance of the Navy Department, died November 10, 1952. A Government engineer for 36 years, he served in the Ordnance Department of the Army in France during the First World War and later as an ordnance engineer. He held several patents on torpedo tubes and torpedo detonator mechanisms.

He transferred to the Navy Department in 1923, receiving an engineering degree at George Washington University in 1927. For his outstanding work in the field of naval ordnance the Navy gave him its highest civilian honor, the Distinguished Civilian Service Award, in 1946.

• **ALFRED GEDEON ANDERSON**, president and cofounder of the Eastern Tool & Manufacturing Company, Belleville, N. J., died on October 31, 1952. He had been an active member of the American Ordnance Association for many years.

Mr. Anderson was born in Gullespang, Sweden, where he served his machinist apprenticeship under his father and became, like his father, a trained machinist. In 1890 Mr. Anderson emigrated to the United States, entering the employ of the Sprague Electric Company in New York City.

In 1898 the Sprague Electric Company was absorbed by the General Electric Company, and Mr. Anderson eventually became toolroom foreman of the General Electric plant in Bloomfield, N. J.

In 1910, Mr. Anderson, together with his brother, Carl E., and C. E. Peterson and the late Adolf Montan, founded the Eastern Tool & Manufacturing Company, in a loft in Newark, N. J., with a fund of $2,800 accumulated by the four associates over a long period from their weekly earnings.

The company has grown from a small wire-forming establishment to the largest fully integrated operation of its kind in the country, involving wire forming, metal stamping, deep drawing, plating, finishing, assembling, in the production of more than 8,000 different items.

Mr. Anderson lived for many years in East Orange, N. J., and for the last fifteen years resided in Glen Ridge, N. J. He was a past treasurer of the Good Templars of Montclair, N. J.

Let the chips fall where they may...

Chase® Free-Cutting Brass is readily cleared

For heavy feeds and high cutting speeds you can't beat Chase Free-Cutting Brass rod and bar. Chips from these Chase copper alloy products are short and brittle and are readily cleared from the cutting tools even during rapid and intricate cutting operations. That means longer production runs and longer life for your tools.

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Ryan Industries of Detroit supplies USAF with rate of climb indicators which must meet rigid test specifications under conditions of high altitude and extreme temperatures.

Standard Bowser test units perform this all-important testing job for Ryan. Indicators are tested at temperatures from −67°F. to +160°F., at altitudes varying from sea level to 50,000 feet.

Rapid pull down time after each test run enables Ryan to deliver *more* of these vital instruments to USAF . . . each pre-tested under accurate flight conditions.

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PROGRESS REPORT . . . Three more high altitude Walk-In test chambers are currently under construction in Bowser's enlarged plant.

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Send information on test equipment checked:

☐ High Temperature	☐ Fungus Resistance
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☐ Altitude	☐ Explosion Proof
☐ Walk-In Rooms	☐ Vapor Tight

☐ Special Engineering 1-5

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Company_____
Street_____
City_____ Zone____ State_____

NEW DEVELOPMENTS

HIGH ALTITUDE SUIT

The development of a new-type pressure suit, enabling pilots to survive in the near-vacuum of the upper atmosphere, was announced recently by the United States Air Force. Called a T-1 high-altitude suit, it is the latest achievement of medical specialists of the Air Research and Development Command's Wright Air Development Center, Dayton, Ohio.

Air Force

The high-altitude pressure suit.

At altitudes above 50,000 feet pure oxygen alone is not sufficient to keep man alive. His lungs must be supercharged to function in the thin atmosphere. Above 63,000 feet man's blood at body temperature will "boil," resulting in his body expanding to twice its normal size. Death results in a matter of seconds.

Doctors, engineers, and technicians of the Aëromedical Laboratory had to solve this problem before progress could be made in developing the jet and rocket aircraft of the future required for this Nation's security. It took these men six years to perfect the suit and helmet to do the job.

The suit is worn uninflated and inflates automatically when cabin pressurization is lost. The inflated suit and helmet supercharge the flier's lungs with high-pressure breathing oxygen and combine a new and unique method of applying counterpressure to the body's surface thus protecting the flier from collapse and making safe operation of the aircraft possible. The suit combines altitude and anti-G protection, crash helmet, oxygen mask, earphones, microphone, goggles and defroster, and oxygen bailout bottle.

LOWER-TORSO ARMOR

A new experimental body armor item for combat troops, designed specifically to afford protection to the hips, abdomen, and groin, has been developed by the Army Quartermaster Corps and will be tested by troops under fire in Korea.

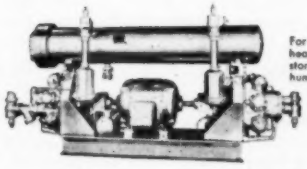
Chrysler Airtemp

A VITAL FORCE IN NATIONAL DEFENSE

"Packaged" Air Conditioner
Easily installed. Cools, dehumidifies, filters, circulates, ventilates. Six models —2-, 3-, 5-, 8-, 11- and 15-H.P. capacities — to meet every cooling need.

Machine Tool Coolant Cooler
Keeps coolants in automatic machine tools at a constant temperature. Helps provide greater precision, higher production. Reduces friction heat.

Chrysler Airtemp has won recognition as an outstanding factor in the national defense effort. By waging war against enemies of production, precision and perishables: uncontrolled dust, humidity and temperatures—Chrysler Airtemp is making a major contribution to the armament program. On all fronts—at home and abroad—in assignments that cover every application of temperature and humidity control, Chrysler Airtemp is serving with distinction. A complete range of products enables Chrysler Airtemp to provide the answer to production problems involving control of indoor atmospheric conditions.



Central Station Unit
For large installations, this unit forms the heart of many air conditioning, cold storage and other temperature and humidity control systems.

Chrysler Airtemp

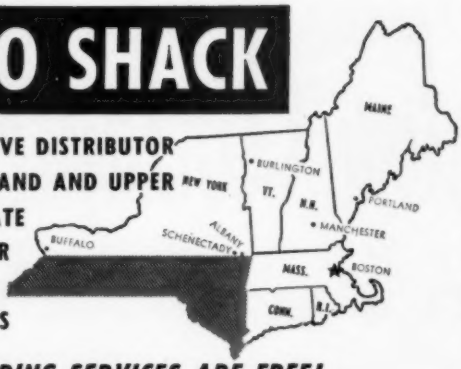
HEATING • AIR CONDITIONING
for **HOMES, BUSINESS, INDUSTRY**

Airtemp Division of Chrysler Corporation, Dayton 1, Ohio

Room Air Conditioner
Fits in window, cools, filters and circulates fresh outside air, expels stale room air. Ideal for offices, hospital convalescent rooms, workshops or other small areas.

RADIO SHACK

IS THE EXCLUSIVE DISTRIBUTOR IN NEW ENGLAND AND UPPER NEW YORK STATE (see map) FOR AMPEX DATA RECORDERS



OUR ENGINEERING SERVICES ARE FREE!

Let Radio Shack's AMPEX-FACTORY-TRAINED personnel help you in the planning and design of the Ampex recording equipment you need for industrial and scientific use. In addition, broadcast and sound engineers are invited to discuss their Ampex needs with our technical staff — regarded by manufacturers and users alike as one of the most competent in this country. Write, wire, or telephone LA 3-3700 in Boston for information and service entirely without obligation.

IMMEDIATE DELIVERY
from stock on all Ampex "300" and "400" series broadcast recorders.

AMPEX

LOW-FLUTTER MODEL 500 MAGNETIC TAPE RECORDER

. . . for the ultimate in data recording

- FLUTTER and WOW: less than 0.1% *peak-to-peak*. Error on final data less than 0.7% using ±7.5% deviation.
- FREQUENCY RESPONSE: within 3 db. from 200 to 80,000 cycles at 60 ips, or 200 to 40,000 cycles at 30 ips.
- SIGNAL-TO-NOISE RATIO: well above 40 db. at the 1% harmonic distortion level, measured in 15% bandwidths.
- FOUR CHANNELS: three for data recording, one for timing reference. All chassis of plug-in construction.
- Meets all relevant JAN specifications and Navy Department Specification 16-E-4.

Write TODAY for your FREE copy of the new 1953 Radio Shack industrial electronics parts catalog, with more than 200 pages listing over 23,000 JAN and standard components with pictures and reference data.

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RADIO SHACK
CORPORATION
167 Washington St., Boston 8, Mass.

New Developments

Tentatively designated Armor, Lower Torso, the new item is to be worn in conjunction with the Army's armored vest. Together, the two garments will afford protective coverage of the entire torso.

The new lower-torso armor is made of the same material as the Army QMC armored vest. It includes 12 layers of flexible, spot-laminated nylon duck, encased in a water-resistant vinyl layer with an outer covering of 6-ounce nylon fabric. The lower-torso armor covers approximately four square feet and weighs about four pounds. The Army's armored vest covers approximately six square feet and weighs about eight pounds.

GAMMA-RAY GENERATOR

A gamma-ray generator designed specifically to give reproducible uniform total body irradiation was unveiled by the Navy recently at the Naval Medical Research Institute, Bethesda, Md. Development of the new gamma-ray generator will help speed the Navy's research into effects of dangerous and penetrating gamma rays on a variety of materials.

First of its type to be built, the generator will allow complete uniform total body irradiation of animals under study which means that every part of the body receives an equal dose of ionizing radiation similar to X-rays. This is not readily obtained by means of X-ray equipment.

ROBOT BALLOON

The Air Force has announced the development of a robot balloon which, carrying meteorological instruments, can maintain a constant, unvarying altitude in the stratosphere for more than three days.

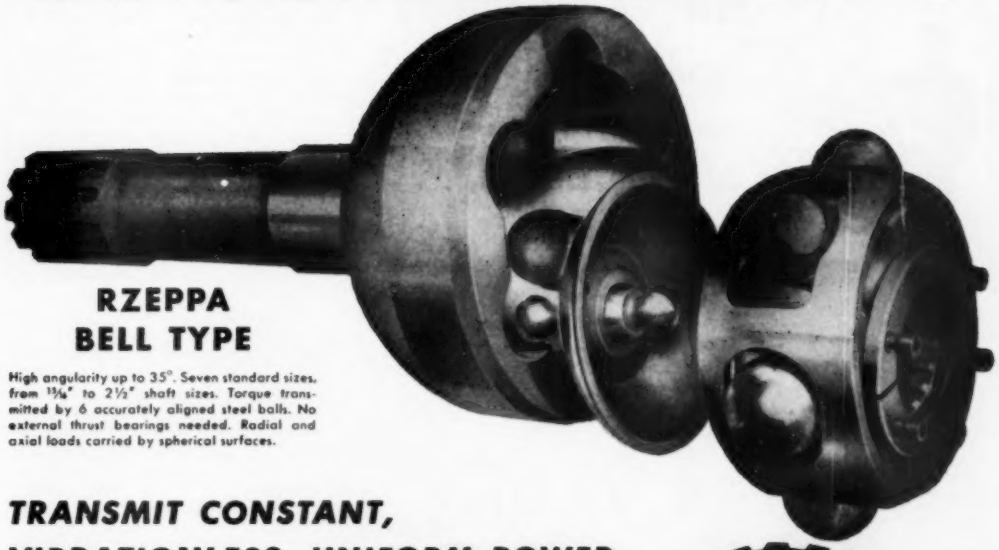
Until now, balloons sent aloft to record air pressure, temperature, winds, cosmic radiation, and other features of the stratospheric region between 50,000 and 100,000 feet have been able to make only comparatively quick sorties. Instruments were released as the balloon passed through the desired altitude. The balloon continued in its ascent until decreasing atmospheric pressure and the sun's heat burst the bag.

The new altitude-controlling device utilizes either fine steel dust or liquid as a ballast, with the ballast discharge controlled automatically by atmospheric pressure. It is preset, before launching, for the desired altitude. The balloons, made of polyethylene plastic, vary in size from 45 to 100 feet in diameter and up to 130 feet in length. The recording equipment is carried in a sling about 100 feet below the bag.

RADIO WAVE LABORATORY

Construction has begun on a major laboratory of the National Bureau of Standards at Boulder, Colo. The new building will house the Bureau's Central Radio

CONSTANT VELOCITY
UNIVERSAL JOINTS



RZEPPA BELL TYPE

High angularity up to 35°. Seven standard sizes, from 15/16" to 2 1/2" shaft sizes. Torque transmitted by 6 accurately aligned steel balls. No external thrust bearings needed. Radial and axial loads carried by spherical surfaces.

TRANSMIT CONSTANT, VIBRATIONLESS, UNIFORM POWER

These joints offer ordnance and industrial design engineers true constant velocity—free from the alternate pulsations that set up vibration even at slight angularity and destructive force as angularity increases.

The field records of over two million Rzeppa joints in the several divisions of our armed forces prove their dependability. The Rzeppa joint consists of an outer driving member and an inner driving member, with a ball cage between them—all assembled into a concentric unit. Each of the six balls transmits torque by free rolling action. No tools are required to assemble the various parts which position each other securely by interlocking. The result is a joint combining great strength, high capacity, constant velocity, compactness, low friction losses and the utmost in dependability.

You are invited to discuss any problems concerning universal joints with our engineering staff, whose long experience in many fields is available to manufacturers of ordnance and industrial products.

RZEPPA DISC TYPE

For low angle operation. Capable of 18° deflection. Sizes from 3-9/16" O.D. taking 15/16" shaft, to 10½" O.D. taking 3" shaft.

MANUFACTURED BY

The GEAR GRINDING MACHINE CO.

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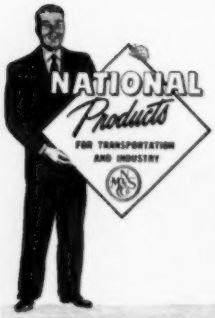
RZEPPA Constant Velocity Universal Joints

Castings by National

selected for Quality and Dependability



Products bearing these familiar trademarks have all established enviable reputations for quality and dependability.

These manufacturers *continue* to procure castings by National—one of the Nation's largest founders.

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National's unparalleled experience in producing malleable, heat-treated malleable, and steel castings is at your disposal. Sales offices and engineering facilities are located at all five strategically located plants. A-5346

PLANTS LOCATED IN Sharon, Pa., Cleveland 6, Ohio, Indianapolis 6, Ind., Melrose Park, Ill., and Chicago 50, Ill.

A 16mm technicolor film. Narrated by Edwin C. Hill, this 27-minute film tells how malleable iron is made . . . tested . . . used . . . how its production economy, ductility, machinability, toughness will give you a better finished product. Available for group showings.

NATIONAL Products FOR TRANSPORTATION AND INDUSTRY

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY
CLEVELAND 6, OHIO Est. 1868

New Developments

Propagation Laboratory on a 210-acre site directly south of the city, near the campus of the University of Colorado. Complete and modern facilities are to be provided for research on the propagation of radio waves and on the expanded utilization of the radio spectrum now being used for FM, television, facsimile, and radar.

The NBS Central Radio Propagation Laboratory is engaged in a broad program of basic and applied research in radio physics and associated geophysical phenomena of the upper atmosphere and the troposphere. The program has four aspects: ionospheric research, systems research, measurement standards, and regular propagation services. Investigations are under way dealing with the properties of matter at radio and microwave frequencies and with the development of techniques for the precise measurement of electrical quantities in these regions.

One aspect of the basic standards and measurement program is concerned with obtaining atomic standards of time and frequency. NBS also participates in an advisory capacity on radio subjects for other agencies of the Government such as the Defense and State Departments and the Federal Communications Commission.

MICRO-TALKIE

The Communications and Electronics Division of Motorola has announced initial mass production of a handie micro-talkie transmitter designed to operate in the 152-174 mc. frequency band. The compact

Tiny transmitter weighs only 29 ounces.

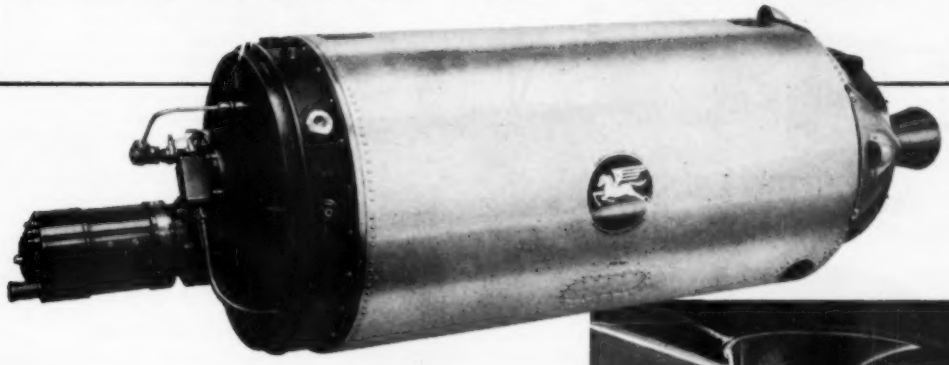
unit, weighing only 1 pound, 13 ounces, has a power output of 20 to 40 milliwatts and a tested optimum range up to 5 miles.

The complete transmitter, including self-contained dry batteries and microphone, is enclosed within a sturdy, seam-welded housing. Over-all case dimensions are only 7⅜ by 2½ by 1¾ inches. A rigid chrome-plated loop antenna doubles as the carrying handle. To achieve extreme compactness without compromising performance, the tiny transmitter uses

NEW HIGH IN SPECIALIZED

POWER

3 LBS. THRUST FROM 1 LB. WEIGHT



The J-44 Monocoque Turbo-Jet Engine... Designed and Built by Fairchild

One of the most compact engines in its power class ever produced is the Fairchild J-44 Monocoque Turbo-Jet. Only 72 inches in length, 22 inches in diameter and weighing only 300 pounds, the J-44 delivers a thrust of 1000 pounds.

Another example of a Fairchild design which met difficult and exacting specifications, the J-44 typifies the creative engineering ability of the Fairchild Engine Division.

Right now, the Fairchild J-44 Monocoque Turbo-Jet is being produced exclusively for the Armed Services. When conditions permit, this mighty midget will become available to boost payloads and lower operating costs of airline transports and other aircraft.

ENGINE AND AIRPLANE CORPORATION

FAIRCHILD

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Hagerstown, Md.

Stratos Division
Bay Shore, L. I., N. Y.

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More and more POWER developments for America's Armed Forces

Impregnate
PRESSURE CASTINGS
Economically

with the NEW 200 Mogullizer

The remarkable MOGULLIZER offers you a positive, low-cost method of impregnating pressure castings to meet the most rigid specifications. Pressure castings impregnated with this equipment have been successfully subjected to severe tests with hot kerosene, hot oil, hot water and other solutions under pressure, with no evidence of porosity remaining.

Meets All Contract Specifications

If your contract calls for casting impregnation, it will pay you to get the facts today on this MOGULLIZER packaged plant which utilizes both pressure and vacuum stages in its operation. MOGUL Cast Seal B is an approved impregnating solution designed by us for use with the MOGULLIZER. Any impregnating materials can be used satisfactorily in these machines.

Designed for High Production

We manufacture other units to meet the needs of every application. We can also furnish special refrigerated units as well as polymerizing tank for use with the MOGULLIZER. Let us know what your production requirements call for.

Write today . . . for free MOGULLIZER literature and our recommendations for your casting salvage problems.

NOTE: There are job shops in certain areas that can take care of your contract work. A few territories are still open for job shop installation. Write for set-up plan today.

METALLIZING COMPANY OF AMERICA

Dept. OM, 3520 West Carroll Avenue
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MOGUL

New Developments

eight subminiature tube stages with "printed" associated circuitry.

GIANT AMPHIBIAN

A 60-ton, amphibious cargo vehicle traveling on 10-foot tires and capable of transporting heavy military equipment was unveiled recently by the Army. In a ship-to-shore operation, the new vehicle demonstrated its ability to take aboard a medium tank, transport it ashore over a soft beach, and unload it inland ready for combat.

Officially designated the Barc, the vehicle was designed by the Army Transportation Corps with consultant advice by Richard C. Kerr, technical consultant of the Arabian American Oil Company, and Roderick Stephens, of Sparkman and Stephens, Inc., both of New York City.

Operating on principles similar to those of the well-known Dukw of World War II, which it closely resembles on a magnified scale, the Barc can perform tasks ashore and afloat far outranging present amphibious vehicles. The Barc has an over-all length of 61 feet, a width of 27½ feet, and a height of 16 feet. Despite its size, it requires only a single operator both on land and in the water and a basic crew of three for all operations.

NEW FIRE FIGHTER

A new aircraft crash fire-extinguishing system which produces twice as much foam as previous systems was demonstrated recently by the Navy. Sponsored by the Navy Bureau of Aëronautics, and developed by the Naval Research Laboratory, the system mounted on a conventional crash truck can cover a burning airplane with approximately 15,000 gallons of thick, sticky, fire-smothering foam and greatly increase the chance of survival of passengers and crew.

The improved system, according to Navy experts, was the result of new designs in nozzles and pumps. It has been incorporated into a new fire-fighting and crash-rescue truck which has two 150-horsepower engines to power two separate foam-making systems.

The necessary raw materials—air, water, and foam concentrate—are whipped together in egg-beater fashion. The resulting foam is forced out through two distributing nozzles on the front fenders of the truck, producing a virtual snowstorm of fire-killing ability. These nozzles are pivoted and continuously adjustable so that the Navy crash crew chief can both direct and regulate the type of foam delivery to suit the conditions of the fire from his shielded position on a "bridge" above and behind the cab of the truck.

As the truck approaches a crashed and burning plane, the crew chief can direct two heavy streams of foam on the fire from distances up to 150 feet away. Sep-

GUTS ON THE GO!

● These action-packed shots are clips from the first movie taken of the new personnel carrier produced by International Harvester. This fording operation, filmed in the field at Fort Knox, speaks for itself! Here is stamina, performance, maneuverability in a rough, tough piece of equipment . . . guts and go to lick any test on proving-ground or battle-ground.

Well over a century of experience in producing a broad line of machines and equipment to serve agriculture, industry and transportation stands behind International Harvester mass-production facilities. Coupled with that experience is proved ability to gear our production facilities to the specialized requirements and the most rigid specifications of the Armed Forces.

INTERNATIONAL HARVESTER CHICAGO 1, ILLINOIS

Rockwell Report

by **W. F. ROCKWELL, JR.**
President
Rockwell Manufacturing Company

NOW AND THEN SOMEONE ATTACKS our patent system on the grounds that it reduces competition. It is our opinion that not only is the truth of the matter exactly opposite, but also that patent protection has encouraged most of the useful research done by business.

Patent law is complex and often frustrating. We have a case in point right now. One of our power tool design patents was, we felt, infringed. A Federal Court upheld our patent. Then another company started building a product which, in our opinion, violated the same patent. Another Federal Court held in this case that the patent was invalid because the device was so simple that it lacked inventive merit. This in spite of the fact that several companies had apparently been working on the idea for years without success.

Experimental research is at best a calculated risk—tedious and costly and often a complete loss. Only adequate—and clear—patent protection which can assure a proper return on the investment can justify long range development work to improve products and broaden markets.

* * *

Several years ago a Delta dealer told us that any time he had asked six or so business men in a group if any of them had a home workshop with Delta tools, that in almost every case at least one man did, and usually more. It's an established fact that hundreds of thousands of men who work with their minds all day find peace and relaxation in their home shop working with their hands during their free hours.

* * *

Short Facts About Rockwell People: One of the most unusual old timers in our company is Harry O. Crane, chief final inspector at our East Chicago, Ind., subsidiary, Edward Valves, Inc. He was one of the original incorporators of Edward in 1908, and from that day to this has been responsible for final testing and inspection of all finished Edward valves . . . Another unusual Rockwell employee is Hans J. Heine, chief metallurgist of our Barberton, O., plant, one of several locations where we build Nordstrom valves. An immigrant from Germany in the late 30's, he has made a hobby of speaking before all kinds of groups on "The Fundamentals of Citizenship," telling his first-hand experience of the blessings of being an American. During the recent election campaign he was up to his neck in get-out-the-vote activities in Barberton and Akron. Still he has time to serve as minister of music in a large Akron church.

* * *

A test pilot who never leaves the ground can be found at our factory in Brooklyn where Rockwell water meters are made. He is in charge of a huge, electrically operated plant that tests meters for accuracy and sensitivity before shipment.

An unusual feature of this test plant is that it can be adjusted to duplicate the actual field operating conditions. For example, meters going to warm climates can be tested for accuracy and response at the same water temperatures they will meet in service. This gives added assurance of satisfactory measurement when installed in the home.

This robot controlled meter testing plant is a custom-made job designed by Rockwell engineers to meet their exacting requirements for accuracy.

* * *

One of our executives is just back from a business trip through Europe. One of his reports interested us particularly: He found that Rockwell-built Delta tools sold secondhand for a higher price than similar but new power tools built in Europe. The reason, according to several dealers in general machinery, was that though Delta tools have never been extensively advertised or sold in Europe, they are better known than their Continental counterpart. American production machinery, they said, will always command a premium in the European market. "American factories are the envy of the world," said one dealer, "so why shouldn't the machinery American factories use sell at the best price."

One of a series of informal reports on the operations and growth of the
ROCKWELL MANUFACTURING COMPANY
PITTSBURGH 8, PA.
for its customers, suppliers, employees, stockholders and other friends

New Developments

arate, fixed ground nozzles then lay a protective foam "carpet" over which the truck can approach the burning plane. At the fire, the crew chief can widen his foam streams by pushing a button, spraying a protective cone of 7,000 gallons of foam a minute, behind which the rescue crew can quickly enter the plane and rescue any trapped occupants.

A new jeep fire engine, featuring a self-contained fire-extinguishing system, also has been unveiled by the Navy. The extinguishing system of the vehicle, designed and built by the Naval Research Laboratory at White Oak, Md., is capable of delivering 1,300 gallons of fire-killing foam a minute for more than two minutes without refilling.

Purpose of the vehicle is primarily for use in fighting aircraft crash fires aboard the larger aircraft carriers.

The midget fire engine, which is powered entirely by its 60-horsepower engine, can spread a protective cone of foam 30 feet in diameter up to 90 feet away through an adjustable nozzle mounted on the fender.

ELECTRONIC MICROMETER

A new model electronic micrometer permits measurements to 0.00002-inch without any measuring pressure being exerted on the work. All measurements are direct—the instrument is not a comparator. The measuring head consists of

New device can measure to 0.00002-inch.

an extremely accurate micrometer screw. An electronic circuit, sensitive to five millionths of an inch displacement at the micrometer tip, gives a visual indication at the moment of contact but before pressure is exerted.

The new electronic micrometer is especially designed for use in research, development, and performance testing of diaphragms and bellows used in flight instruments, temperature, refrigerator, and other types of controls where a pressureless means of testing is required.

TITANIUM REPLACES STEEL

Titanium will be used in certain airframe parts in B-36 aircraft in lieu of

Chapman Casts World's Largest Stainless Gate Valve

9-ton casting produced in austenitic chromium-nickel stainless steel

This valve, produced by The Chapman Valve Manufacturing Co., Indian Orchard, Mass., for the defense effort, is used in corrosive water service. It is stated to be the world's largest, with an overall height of 19 feet, weighing approximately 18,000 pounds. The rough casting weight was approximately 36,000 pounds.

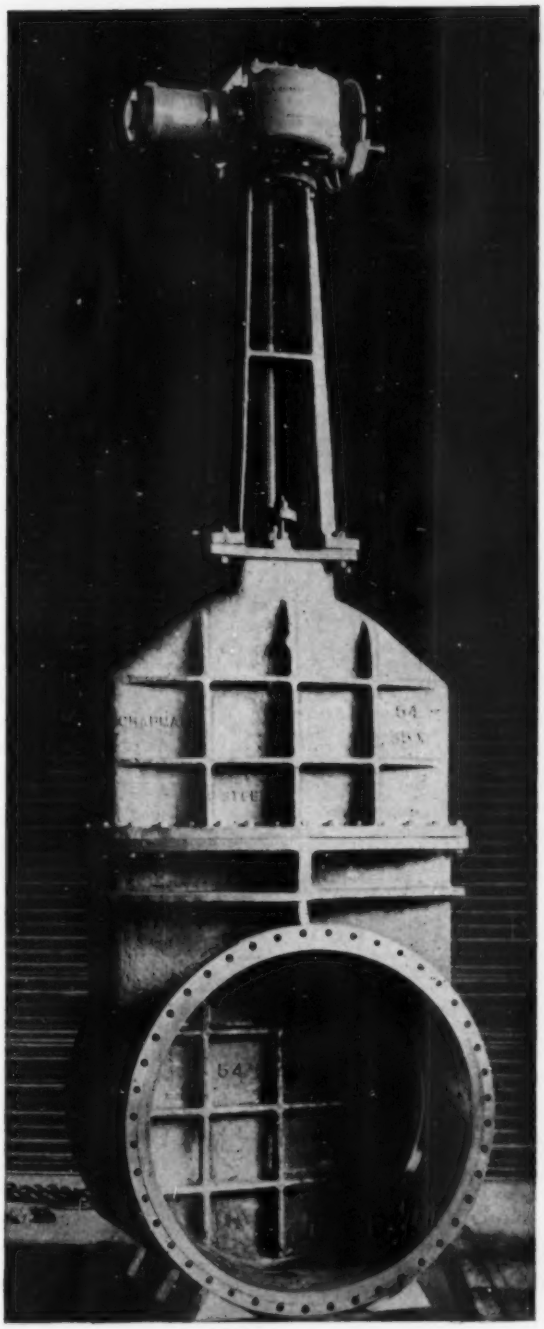
Cast in low carbon 18-8 chromium-nickel stainless steel, it is one more demonstration that size is no limiting factor when you cast parts in stainless steels to provide resistance to corrosion and erosion.

Stainless steel resists attack by nearly all oxidizing acid conditions. In addition, it helps you trim bulk and deadweight without sacrificing strength and safety.

At elevated temperatures, austenitic chromium-nickel stainless steels are distinguished by their strength and outstanding resistance to oxidation. At temperatures down to −320° F. they retain their toughness and unusual strength.

Investigate all the benefits stainless steels can give you. Leading stainless steel companies and foundries produce nickel-containing stainless steels in all commercial forms. A list of sources of supply will be furnished on request.

At the present time, the bulk of the nickel produced is being diverted to defense. Through application to the appropriate authorities, nickel is obtainable for the production of austenitic stainless steels for many end uses in defense and defense supporting industries.



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SPECIFICATIONS

UL approved for 20 ampere, 125 volt, 1 HP or 10 ampere, 250 volt operation, AC only. Timings available from 60 seconds to 3 hours. Normally supplied with center stud mounting. Other mountings available on request.

This Mark-Time switch is built to uphold the reputation of your product. Install it in your appliances, devices or machines, and give your customers a *double-purpose* time switch. "5400" turns OFF the circuit at the end of a pre-set time period . . . and gives a clear warning bell signal. Your customers will like that *double service!*

"5400" has a wide range of applications . . . is available with a wide variety of modern dials and knobs . . . can be supplied as an "ON" type of unit on special order.

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MARK-TIME

M. H. RHODES, INC.

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Manufactured and sold in Canada by SPERRY GYROSCOPE OTTAWA, Limited 3 Hamilton St., Ottawa, Ontario, Canada

New Developments

sheet steel, the U. S. Air Force announced recently. This is the first use of titanium in aircraft production. Sheet titanium in commercially pure form will be used on a gauge-for-gauge basis, replacing steel in several applications. Approximately 530 pounds of the metal will be used in each plane.

Titanium offers substantial improvements over metals now used in aircraft because of its high strength-to-weight ratio and in its heat- and corrosion-resistant qualities. In nonstructural uses, where it replaces steel on a gauge-for-gauge basis, there is approximately a forty per cent saving in weight.

NEW GUIDANCE SYSTEM

A new gyro-based system of control for guided missiles will be impervious to enemy "jamming," according to *Aero Digest*. Radar or radio blocks, dummy heat sources, or even the high winds in the stratosphere will have no effect on its accuracy. Once set in motion, nothing short of a change of the earth's course in space can mislead the gyrostabilized and gyro-navigated missile. It will drive unerringly to its target and cannot be enemy-influenced by anything other than direct interception by fighters or countermissiles. At very high supersonic speed, this is considered extremely unlikely by missile experts.

Although the gyroscope has been used for navigation since before World War I and to assist pilots for many years, its size, weight, and accuracy have not been such as to suggest its possible use as a complete replacement for the human element until recently. The new gyro-based system not only will fly the missile but will actually seek out predetermined locations in any sequence. Indications are, for example, the missile might be fired from Washington, turn directly north over London, turn east over Stockholm, and directly south over Archangel and from there take any predetermined course to its target.

With this "thinking" ability, the coming system is believed the answer to the limitations of the human pilot, which are becoming more and more restrictive on supersonic, stratospheric fighters and bombers. While until now no gyroscope capable of holding a missile on an accurate course for as far as 5,000 miles has been built, means are now available for obtaining such accuracy, it is reported.

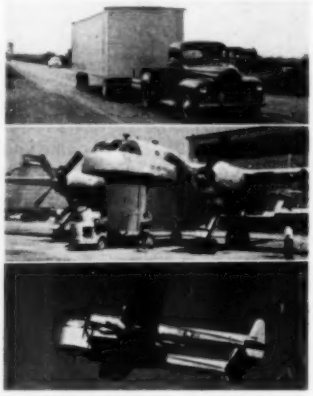
BULLETPROOF GAS TANK

A bulletproof, self-sealing gasoline tank made of silk, wool, or other cloth has recently been developed, according to *Science News Letter*. The tank, for use in military aircraft where weight is a big factor, is made of several layers of cloth glued together on the bias. Inside the cloth is a self-sealing liner, made of a material which will swell upon contact with gasoline. The swelling seals the bullet holes.

The great advantage of the cloth, according to the inventors, is that, unlike aluminum or other soft metals, a bullet will not leave jagged holes nor will the pressure created inside the tank by the passage of the bullet cause strains on joints or rivets.

FLYING TRAILER

Designed as a detachable cargo compartment for the unique Fairchild XC-120 Pack Plane, the recently developed "flying trailer" represents a new concept in military and civil air cargo transportation. A further development of the XC-120's original pod, the versatility of the flying trailer hinges on its adaptability to both ground and flight situations.



The new Fairchild trailer can travel over the road like a truck rig, top. At the airport it is attached to the XC-120 Pack Plane, center, which then takes off and flies like a regular transport, bottom.

In military use, it can be loaded with as much cargo as a C-119 Flying Boxcar, attached to the XC-120 in a few minutes, and flown to forward combat areas. Upon landing at advanced bases or airstrips, the trailer can be hitched to virtually any military vehicle and hauled to a forward area. Extreme maneuverability and high-speed over-the-road characteristics may render it especially valuable from a logistics standpoint in supporting and air-supplying ground operations.

The flying trailer features two different configurations for flight and ground use. Under highway conditions, the front and rear cargo doors are folded flat to meet road regulations regarding over-all vehicle length. Before the jack is hoisted under the XC-120 for aërial delivery, the doors are opened and locked in a modified "V" shape to cut air resistance aloft. Wheel

60

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Strategically located to serve suppliers of all government services, Wirebound Box manufacturers are in excellent position to meet your shipping container needs. Parts boxes, equipment crates, over-packs and food containers are but a few of the multitude of uses for which Wirebound containers are adaptable. Wirebound manufacturers are informed, experienced and technically trained to design, produce and pre-test scientific containers for each use. Make it a point to consult your nearest Wirebound supplier or write for full information.

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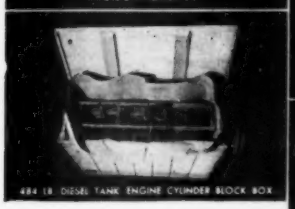
CYLINDER BOX

IMMERSION HEATER BOX


484 LB. DIESEL TANK ENGINE CYLINDER BLOCK BOX

FIELD RANGE CRATE

CHEMICAL BOMB BOX

TYPICAL OVERSEAS OVER-PACK

PROJECTILE BOX

PRACTICE BOMB CRATE

Wirebound
BOXES & CRATES
Users names on request

CANNON PLUGS *to* **ARMY ORDNANCE** *specification*

AO Cannon Type AO Series connectors are manufactured under the latest specification pertaining to electrical systems for military vehicles and associated external electrical equipment. "AO" connectors will mate with standard "AN" fittings. Are ideal for heavy duty industrial use.

This new series is designed to withstand extreme conditions of temperature, moisture, dust, vibration and shock. Shell material is aluminum alloy with natural iridite finish. Insulators are of a special molded resilient material having high dielectric strength, medium oil resistance and will not support combustion. Resilient grommet provides moisture proofing over solder terminals.

For engineering data, request Bulletin AO-1952.

SOCKET INSERT ASSEMBLY TYPE AO-RA00 WITH GROMMET RETAINING NUT

TYPE AO-PA06 WITH GROMMET RETAINING NUT

SOCKET INSERT ASSEMBLY TYPE AO-RB02

PIN INSERT ASSEMBLY TYPE AO-RB02

AO TRAILER RECEPTACLE

DUST CAP

AO SLAVE RECEPTACLE

TYPE AO-22 ANGLE 90° ELBOW

WRITE FOR BULLETIN AO-1952

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Factories in Los Angeles, Toronto, New Haven, Benton Harbor. Representatives in principal cities. Address inquiries to Cannon Electric Company, Dept. A-133 P. O. Box 75, Lincoln Heights Station, Los Angeles 31, Calif.

New Developments

assemblies, which include shock absorbers and standard truck-type wheels and tires, are removed prior to flight and stowed aboard the trailer.

NEW ELECTRICAL LAB

The establishment of a new electrical laboratory at the U.S. Naval Engineering Experiment Station, Annapolis, Md., brings the number of major laboratories which perform various engineering services for the fleet to seven. The new electrical laboratory is concerned with testing and developing shipboard interior communication equipment, rotating electrical equipment and regulating devices, and with the suppression of radio interference.

Items such as switchboard components, alarm bells, fire- and vapor-detecting devices, salinity indicators, speed logs, engine telegraphs, and indicating and monitoring devices are evaluated and modified, where necessary, for the safe and efficient operation of naval vessels. Generator sets, motor drives for pumps, compressors, blowers, and the like, are tested to determine their suitability for use aboard ship. A project to improve instrument illumination is under way in the newly formed laboratory.

DELTA-WING FIGHTER

The U. S. Air Force F-102, America's first supersonic delta-wing interceptor, has been ordered into initial production. The new aircraft will be built by Consolidated Vultee Aircraft Corporation at San Diego, Calif. Designed for very high speeds in the stratosphere, the F-102 will incorporate significant improvements in armament and electronics.

Because of its delta wing, the F-102 resembles in general the first known delta-wing aircraft to fly, the XF-92, which Convair built as a research interceptor for the Air Force. The XF-92 has been flown extensively since 1948, principally at Edwards Air Force Base in California.

GIANT RADIO TOWER

One of the highest man-made structures in the world stretches into the sky in upstate New York to provide Air Research and Development Command scientists with data required to improve constantly the United States Air Force's utilization of radio.

This structure is a 1,218-foot radio tower located at Forestport, N. Y., and is utilized by the Rome Air Development Center at Griffiss Air Force Base, N. Y. At this center, one of nine under the Air Research and Development Command, the Air Force concentrates its development work in the field of electronics. Beaming experimental radio waves over a large expanse of the universe, the tower fills an urgent electronics development require-

KEEPING 'EM ROLLING – *Both Ways!*

You'll see them booming down U. S. Highway No. 1, or wallowing through the mudholes of Korea.

They're the backbone of America's transport, in peace as well as war—our vital motor truck fleet! Trucks are in the vanguard of every mass movement of Americans and American goods, civilian or military. And wherever our motor transport rolls, there too go Timken-Detroit Axles and Brakes.

Since the first trucks were built, more than forty years ago, The Timken-Detroit Axle Company has led the way in the engineering development and constant improvement of axles, brakes and other essential components, unmatched for the soundness of their advanced design and unequaled for dependability and long life.

Among the highest achievements of modern transport progress are such Timken-Detroit developments as heavy-duty Hypoid Gearing, wide interchangeability of final drives and parts, integrated tandem drive units, and many others.

Today, as always, Timken-Detroit engineering and manufacturing resources are concentrated on the production of vital components for essential trucks, buses and trailers, both civilian and military. It is this concentration, over the years, which has made The Timken-Detroit Axle Company the foremost engineering-manufacturing organization in its field.

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FOR THREE WARS we have supplied the U. S. Government and prime contractors with fine instrument screws and components for military equipment . . . Waltham Screw Company is recognized as a leading producer of ammunition components, fuze parts, small arms parts, and special contract parts . . . Made exactly to Government specifications . . .

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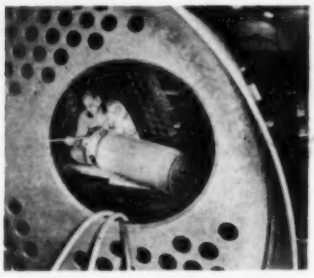
ment for the Nation. The tower required 772 tons of fabricated steel and is supported by 4 miles of guy cables, some of which are anchored almost a quarter of a mile from the tower's base.

Not many years ago a tower of this type and height would have been considered impractical to build—even though the Empire State Building and its TV antenna, which reaches a total height of 1,450 feet above the ground, was a reality. However, except for height, the Empire State Building and the Rome Air Development Tower have little in common. The Empire State is a solid mass built on bed rock. The tower is a vertical antenna of open framework, a guyed steel structure, shaped as an equilateral triangle whose sides are spaced fifteen feet from center to center of the leg members. The tower's foundation rests on crystalline sand derived from wastage of quartz rose rocks with moraine deposits beneath.

MIDGET X-RAY

A new midget-type industrial 250,000-volt X-ray machine, less than half the size and less than one-eighth the weight of the conventional quarter-million-volt unit, was exhibited recently by the General Electric Company. This lightweight, mobile



Lightweight X-ray machine in use.

unit, although capable of X-raying steel up to 3½ inches in thickness, can be easily carried around in foundries, welding shops, shipyards, building projects, and on many other jobs where X-ray inspections are needed to control quality and safety.

The unit is less than 15 inches in diameter and 44 inches long; weighs only 150 pounds, as against 1,150 for conventional units. The first major application, according to General Electric, has been made in U.S. Navy shipyards where it is used to inspect critical welded seams and stressed areas in ships during and after construction.

PACKAGED ASPHALT

The Engineer Corps is investigating the practicability of packaging certain

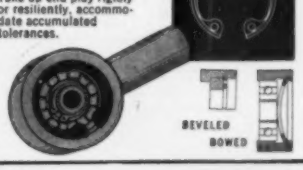
Speed Production, save material and machining operations with Waldes Truarc Retaining Rings

better way to hold parts together

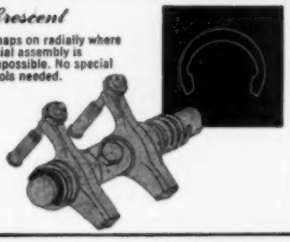
THERE'S A TRUARC RING FOR EVERY PURPOSE

Standard* — Forms secure shoulder for tight pressure fit when installed in groove.

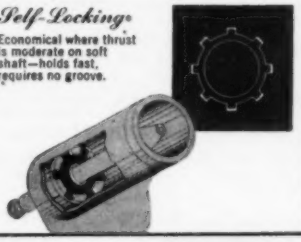
Beveled* and Bowed* — Take up end play rigidly or resiliently, accommodate accumulated tolerances.



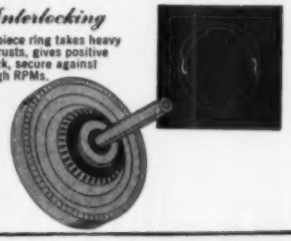
Crescent — Snaps on radially where axial assembly is impossible. No special tools needed.



Self-Locking* — Economical where thrust is moderate on soft shaft—holds fast, requires no groove.

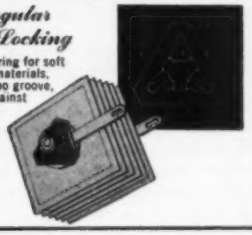


Interlocking — 2-piece ring takes heavy thrusts, gives positive lock, secure against high RPMs.



Inverted* — Provides uniform shoulder for curved abutting surfaces, for bearings with large corner radii.

Triangular Self-Locking — Low cost ring for soft shafting materials, requires no groove, secure against vibration.



E-Ring — Provides large strong shoulder for small shaft. Applied radially.

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Thousands of smart manufacturers are *stepping up* production, while actually *cutting* costs—with Waldes Truarc Retaining Rings! Truarc Rings simplify your designs. The ease with which they can be assembled and disassembled makes them superior in many fastening applications where machined shoulders, nuts, bolts, snap rings or cotter pins have been used.

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INQUIRIES PROMPTLY ANSWERED

New Developments

types of asphalt in multiwall paper bags for shipment to Army construction engineers in all parts of the world. The bags, currently undergoing rigid tests, hold one hundred pounds of asphalt.

The asphalt is loaded into the bags in liquid form. This is done by heating it to pouring consistency. The liquid is then poured through a hose into the bags, which are placed in wooden scaffolds to help them retain their shapes. A clay coating on the inner bag liner prevents the hot asphalt from sticking to the paper and facilitates stripping of the bag from the contents.

After the bags are filled, they are stored for approximately twenty-four hours during which time the asphalt cools and hardens. This cooling and setting period is necessary before the packaged asphalt can be handled. Upon arrival at its destination the asphalt is ready for use by merely cutting the bags with a sharp knife and stripping the paper.

NEW MOTOR LUBRICANTS

A joint Navy-industry program during the past five years has resulted in the development of new high-temperature lubricants which promise to add greater efficiency to electric-motor operation. The new lubricants will allow continual operation of electric motors at 150 degrees centigrade and, at the same time, prolong the intervals between lubrications.

These intervals can be much longer if the motors are operated below that temperature for over fifty per cent of the time. Still longer intervals between lubrication will be possible when the motor design changes indicated by the study have been made.

Nine newly developed greases—all of which are now commercially available, were investigated and tested. Lowering the operating temperature to 125 degrees centigrade resulted in a large increase in the life of all the greases tested, the silicone-soap greases having a clear advantage over all the others.

JET PLANE STARTER

Delivery of the first mass-produced, combustion self-starter for the latest jet planes was announced recently. The typewriter-size 75-pound starter, which burns a mixture of high-pressure air and jet fuel and develops 340 horsepower—equivalent to two of the highest-powered Buick auto motors—was flown immediately to the Buick Motor Division of General Motors Corporation at Flint, Mich., for installation on a Sapphire jet engine, power plant for the new Air Force F-84-F fighter-bomber. Buick is building the Sapphire engine under a defense contract.

The new starter provides the first means of starting large jet power plants with a completely airborne, self-contained unit operating independently of ground crews. It was designed and developed by the Eclipse-Pioneer Division of Bendix Aviation Corporation and is now beginning to roll off the production lines of the company's Utica, N.Y., division.

The new starter equips U.S. military aircraft for the first time with virtually instantaneous, push-button starting. It develops and expends its enormous power in but 3½ seconds, and in this short interval the starter gives such a powerful impetus to a jet airplane's main turbine that full engine speed required for take-off can be reached in only a few additional seconds.

10-TON GAGE

What is believed to be the largest gaging device ever built was demonstrated recently at the plant of the Sheffield Corporation, Dayton, Ohio. Designed and built by Sheffield with the coöperation of experts at Picatinny Arsenal, the huge gage checks the dimensions of loaded and assembled rounds of 90-mm. ammunition. It is the first of its kind and has been named the "Chambermatic."

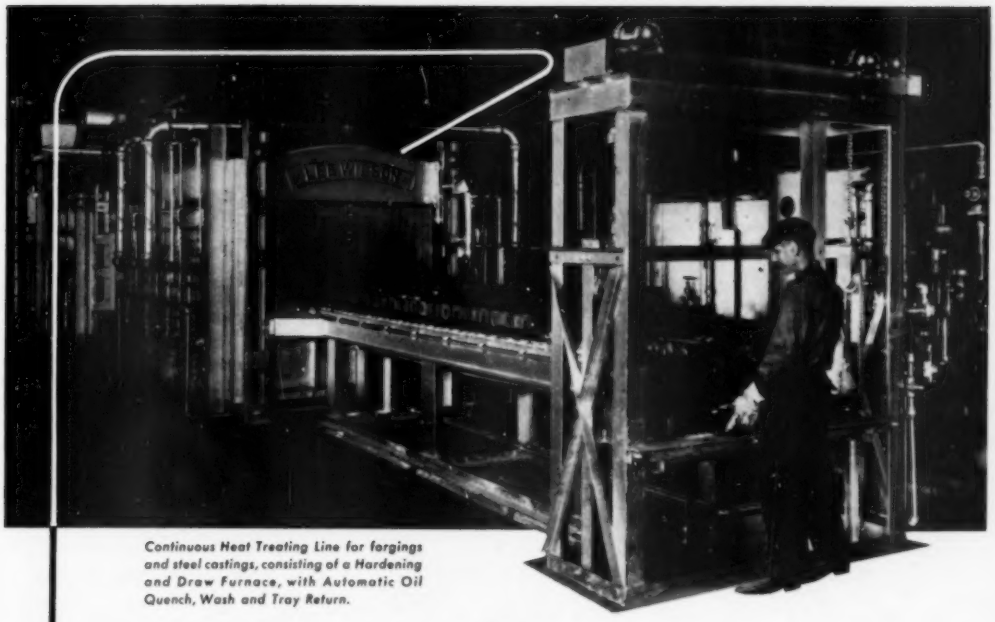
The "elephant-size" gage, which weighs approximately ten tons, receives the 43-pound round, measuring three feet in length, after it has been filled with the high-explosive bursting charge and the propelling powder. The round is then presented to the maximum profile and alignment chamber gage by mechanical handling. A chamber gage is similar in shape to the chamber of the gun, but its dimensions are accurately controlled to a few ten-thousandths of an inch.

If the assembled round fits within the chamber gage it is acceptable and provides assurance that components manufactured in hundreds of plants throughout the United States will fit and function in the chambers of guns made by various manufacturers. Any eccentric, misaligned, or oversize rounds will be rejected by this mechanized chamber gage, and after rejection they are mechanically segregated from the acceptable ammunition. Rounds that are accurate after passing through the chamber gage are mechanically moved out of the machine to the point where they are packed for issue to the using troops.

COLDBAR UNIFORM

The Quartermaster Corps' experimental special-purpose Coldbar winter uniform, which has passed preliminary climatic tests in the United States, will be given extensive battle-testing by Army troops in Korea this winter.

Developed by Army Quartermaster research and development technologists, the Coldbar uniform employs the vapor-barrier principle utilized in the Army's new insulated boot. It marks a departure from conventional clothing in that no cotton, wool, or other fiber is used in the construction of the basic garments, which are made of a soft synthetic substance.



Continuous Heat Treating Line for forgings and steel castings, consisting of a Hardening and Draw Furnace, with Automatic Oil Quench, Wash and Tray Return.

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Gun Barrels, Mounts, Breech Blocks
Recoilless Rifle and Mortar Tubing
Aircraft Jet Parts
Bullet Core Rod
Artillery Shells
Tank Turrets—Hulls—Race Rings
Propellers—Aluminum Alloy or Alloy Steel
Landing Gears—Airframes
Steel Casting Annealing

ALUMINUM HEAT TREATING INCLUDING

Homogenizing furnaces
Preheating furnaces—Reheat furnaces
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In the "Minds of Men" are created the engineering designs for the custom building and erection of modern heat treating furnaces and auxiliary equipment. This is the important story behind any furnace installation. The Lee Wilson Contracting Company using the Designs and Patents of Lee Wilson Engineering Co., Inc. has combined experience in design and erection totaling "hundreds of engineering years" at your disposal. We cordially invite your request for bids or expression of interest.

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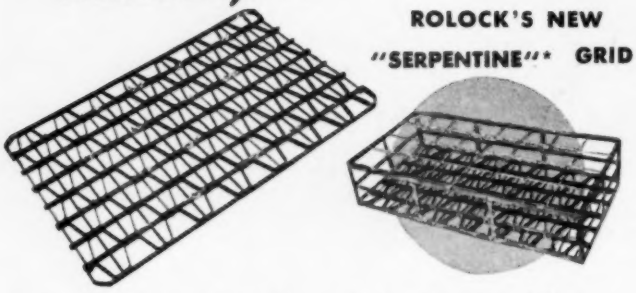

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* Patent applied for

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COMMUNICATIONS

USE OF ATOMIC POWER

THE EDITORS.—A mutual friend was good enough to send me a copy of your Washington newsletter, THE COMMON DEFENSE, No. 144.

I note your comments on "Public vs. Private Atomics." You say: "Private industry has many a high hurdle to jump before it can get partial or complete control of atomic energy for power production and other peacetime purposes."

Why should it be "partial or complete control"? Why should it not be "partial use of atomic power"?

I think some of those questions can be answered but will not be answered if the present policy of fear to make decisions is continued.

B. M. BARUCH

New York, N. Y.

RELATIVE TEMPERATURES

THE EDITORS.—I have read with interest your issue No. 143 of THE COMMON DEFENSE. I wish to point out, however, the erroneous conclusions drawn in the item referring to the high temperature encountered at altitudes of 400 miles. Factors to consider are these:

Although the thermometer may indicate "4,000" degrees, the specific heat and the density of the medium are very low. As an example, you may thrust your arm into an oven at 500 degrees for a short period of time, but don't try it in cooking oil at the same temperature!

It is quite possible that ordinary metals with the proper reflectivity may prove entirely adequate for structures passing through "high-temperature zones" in short periods of time.

Remember that the "quantity" of heat, or rather the number of molecules evidencing the 4,000-degree temperature at an altitude of 400 miles (low pressure) may be equivalent to a far greater mass of air heated to a lower temperature at lower altitude.

I just wished to point these few facts out in the interest of keeping us from feeling that many of the "space problems" are too difficult for solution.

ROBERT M. VIRKUS

La Grange, Ill.

DEFENSE EXPENDITURES

THE EDITORS.—Your issue No. 143 of THE COMMON DEFENSE outlines the difficulties facing our military organization in securing adequate appropriations for our

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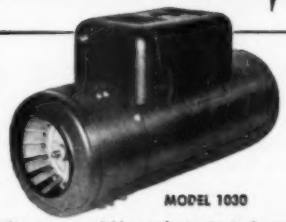

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Communications

defense programs and points out the additional roadblocks which are placed in their way in carrying out the expenditures of these funds.

As a member of the 13th Joint Civilian Orientation Conference and as a producer of military articles for the Army, Navy, and Air Force, I am quite familiar with many of the complexities which seem to prevent the United States from receiving full value for its defense expenditures. I am very much in favor of the congressional investigations which periodically seem to reveal waste and inefficiency in our military establishment. These inquiries seem to be the only way the legislative branch of our Government can prod the military into increased efficiencies.

It does seem too bad, however, that many of the retarding influences mentioned in THE COMMON DEFENSE cannot be lifted from the backs of the conscientious civilian and military officials of our Defense Department to enable them to do a more satisfactory job.

Is the American Ordnance Association making any effort to improve this situation, both within the legislative and executive branches of our Government? Since military expenditures are the largest part of our national budget, it would appear to me that the problems you brought forth should receive most serious attention by an organization such as the American Ordnance Association. The entire American public would welcome whatever improvements the American Ordnance Association or any other similar organization could help institute.

ROBERT S. INGERSOLL
Chicago, Ill.

■ **The American Ordnance Association, through its Technical Divisions and Committees as well as its local Posts, is striving in every possible way to improve the defense situation. However, the Association definitely does not attempt to influence legislation—a field which is beyond its scope, as such activities are specifically prohibited by the constitution of the A.O.A.**—THE EDITORS.

WHITHER COMPLEXITY?

THE EDITORS.—After reading in the November-December 1952 issue of ORDNANCE the articles "We Can Have Guns and Butter," and "Double Production for Defense," and looking around my own location, I get scared. The new developments such as the H-bomb, atomic artillery, electronic fire-control systems, cross-drive transmissions and the like, and rapid production of these items sound swell.

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Service records keep confirming the production advantages of the Unichrome S.R.H.S. Chromium Bath. Two typical cases: An aircraft supplier plates steel bushings in 2½ to 3 hours with this bath, instead of 6 hours required in the ordinary bath. And the plate is smoother, reducing polishing time, too. Another concern doubled production of plated machine tool parts when it switched to Unichrome S.R.H.S. Bath.

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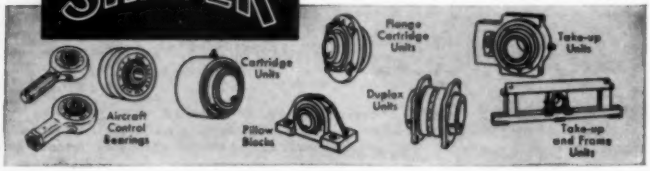

Communications

The United States is producing the best—but I'm still scared.

Designers, metallurgists, and production men are really putting out—a great successful effort on their part—but I'm still scared. Who is going to operate and maintain all this complex equipment—industry?

Yes, I'm scared, for as I look around at all this wonderful, complex equipment, I see the men who must operate and maintain this equipment stumbling along. I'm not scared that we will reach a point where industry has progressed beyond the user, for that has already happened—I'm scared that the user will never catch up, but he must if the United States is to make good and efficient use of this wonderful equipment.

The Army, under current civilian controls is not able to train men fast enough nor pay them enough to keep up with these technological advances. Each new "gimmick" or improvement in design means more training time required—time that now amounts to almost half of an enlistment. Even then, when the Army is successful in training an individual to operate and maintain this new-fangled equipment, along with his military training, his enlistment expires after but little use of the man in the job for which he was trained.

Does the man reënlist? No, he goes to work for industry. True, he uses his training received in the Army, but he is lost to the Army, and a new training cycle begins.

This problem is reaching an astounding proportion, not only in the technical services, but also among the line units.

As an example, a good maintenance man on a fire-control system requires one year of training; an operator of this system, eight months. If we continue to *progress* at this rate, we soon will be training a man his full enlistment so that industry will have a trained man in the end—and who is going to be left in the Army?

I may sound critical—there are both constructive and destructive types of criticism—but where are we going with all this rapid production of highly technical items? This to me is a problem that industry must realize from its own experience. Civilian industry is the backbone behind the American people and we should enlist its aid to help the Army—and Ordnance.

E. R. URQUHART

Richland, Wash.

■ **An interesting and informative article, on the subject of complex weapons, "Building Dependable Ordnance," by Vernon M. Korty, was published in the September-October 1952 issue of ORDNANCE magazine. The article appeared on page 350.—THE EDITORS.**

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FROM THE RECORD

AIRCRAFT ARMAMENT

Our present aircraft armament equipment is the outgrowth of two strong influences: (a) World War II developments—radar, electronic computing devices, and automatic control theory; and (b) Operational requirements for performance in new régimes of speed, altitude, and range.

Overshadowing these influences is the atomic bomb. It is no wonder that the past few years have produced armament systems that have no resemblance to the equipment used in World War II! . . .

The Weapons System

The integration of bomb, radars, computers, airframe, engine, and all necessary supporting equipment produces a "weapons system." Balance must be preserved among the components of the whole. Each component must justify its place on the team, and any part that is a weak link or has a difficult task to perform must receive special emphasis. . . .

The performance of the F-86 versus the MIG-15 in Korea proves that the Air Force has placed a well-balanced weapons system against the enemy. Although outnumbered and forced to fight in an unfavorable tactical situation—handing the enemy the advantages of a privileged sanctuary, a "King's X" zone, as it were—the ratio of MIG-15 kills to F-86 losses continues to climb. . . .

One significant difference between the enemy weapons system —represented by the MIG-15 and its cannon—and the F-86 and its machine guns is the U. S. use of a fire-control system for aiming the guns. The F-86 has a small automatic radar that automatically measures range to the target and continuously furnishes this information to the computing system. Gyroscopes measure the rate of turning of the aircraft (which is a measure of the relative speed of the aircraft and the angles involved), and the system automatically computes the lead angle. In addition, it provides an indication of the size and direction of lead. . . .

Hitting a moving target is very difficult, as any one who has shot at a jackrabbit from a moving car will know. Jet airplanes are very small, and the time available to aim is only a matter of seconds. They enter combat at ten miles a minute and break away in circles which may carry them out of sight of each other. The enemy twists and turns and dives and zooms in maneuvers which test the stamina of the pilots to withstand the accelerations.

In this combat, no human being has the sensory capability to measure the enemy speed, the range, and the angles involved. If he did have the exact data required, the time available is too short to make even the simplest calculation. Even though the pilot may seem to be directly behind his target, the motion of the two airplanes turning in space will cause the bullets to miss the target.

Electronic Equipment Adopted

Therefore, to strengthen this part of the weapons-system team, the Air Force has adopted electronic and gyroscopic equipment to help the pilot. This equipment weighs 85 pounds for the radar and 120 pounds for the computer and optics. That weight is about two per cent of the total aircraft weight and represents about four per cent of the total cost. We have enough data from pilots' reports and combat film to prove that it is an important factor in the over-all effectiveness of the F-86.—Brig. Gen. Leighton I. Davis, *Director of Armament, Office of the Deputy for Development, Air Research and Development Command, before the Institute of Aëronautical Sciences, Cleveland, Ohio.*

Sgt. 1st Class Einar H. Ingman U. S. Army Medal of Honor

"The sergeant charged alone . . ."

THE REDS IN AMBUSH on the ridge had lain concealed, withholding their fire. Now they opened up. The two squads were trapped. Their leaders were wounded; others were dropping.

Sgt. Ingman took command. He reorganized the survivors, assigned fields of fire, encouraged the men to fight. A red machine gun opened fire. The sergeant charged it alone, neutralizing it with a grenade.

Then he tackled another gun. A grenade and a burst of fire knocked him down, badly wounded. He got up, reached the gun, and dispatched the entire crew. When his squad reached him, they found Sergeant Ingman unconscious—but 100 of the enemy fleeing in panic.

"Bucking the Communists," says Sergeant Ingman, "takes an awful lot of staying power. The G.I.'s have got it. You have, too, when you invest part of your hard-earned pay *regularly* in Bonds."

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For peace and prosperity save with U.S. Defense Bonds!

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Book REVIEWS

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BRIG. GEN. THOMAS K. VINCENT, *artillerist, engineer, author, Redstone Arsenal, Huntsville, Ala.*

Fleet Admiral King: A Naval Record. By Ernest J. King and Walter Muir Whitehill. New York: W. W. Norton & Company. 657 pp. $6.75.

THE memoirs of Fleet Adm. Ernest J. King, Commander in Chief, United States Fleet, and Chief of Naval Operations, 1941-1945, have been eagerly awaited for many years. The Admiral was counted on to furnish a bluntly outspoken record of his stewardship, and in this respect his book comes up to expectations. The daily press noted its publication with headlines and columns reporting his disagreements with the late James Forrestal and occasionally with President Roosevelt and his sharp comments about the defense of Pearl Harbor.

Historians will look to his book for the Admiral's views on plans, grand strategy, and the conduct of the war at sea. Readers of ORDNANCE will regret that logistics is disposed of in a few pages with the comment on the fact that it was not until March 1942 that strategy and logistics were finally brought into proper relation with each other in the Navy. Nevertheless these pages are of great importance in describing organizational changes and efforts for even more radical modifications that President Roosevelt was unwilling to approve.

Most of our World War II leaders have reported only on their war careers. Admiral King, with the collaboration of Comdr. Walter M. Whitehill, tells, with the use of the third person, about the Admiral's ancestry, his education, and his diversified experiences as a line and staff officer in the U. S. Navy.

The supreme test of his ability came when he established headquarters in Washington after Pearl Harbor. Then "many basic policies that King had learned from Admiral Mayo during World War I, and had in turn followed during his command of the Atlantic Fleet, were applied to the new emergency. Here, more than ever before, was a situation requiring decentralization and the encouragement of intelligent initiative of the subordinate. Here, too, was the supreme test of making the best of what he had, for, in all conscience, King had little enough to work with!"

Although these memoirs are sometimes heavy going, they reward careful reading as the record of one of the most effective

RUGGED as a RHINO . . .

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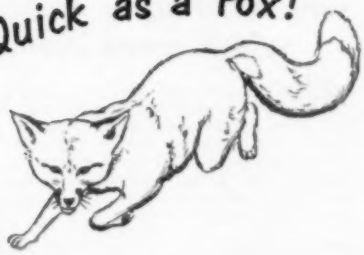

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GOVERNMENT FINISH SPECIFICATIONS

and the Parker Products which meet them

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Grade I	Bonderite 100, 125, 140, 160, 170, 180
Grade II	
Type 2	Parco Cleaners 341, 350, 371
Type 4	Parco Cleaners 250, 260
Type 5	Parco Cleaners 210, 220
Type 6	Parco Cleaners 100, 101, 110
MIL-10578 (Formerly U.S.A. 3-213)	
Type I (Wash-off)	Parco Cleaner 250
Type II (Wipe-off)	Parco Cleaner 260
MIL-C-5541 (Formerly AN-C-170)	Bonderite 700 (chemical film for aluminum and its alloys)
MIL-C-16232 (BuORD)	
Type I	Parco Lubrite 1 & 2
Type II	Parco Compound
PA-PD-191	
Grade I	Bonderite 32, 34, 100, 125, 140, 160, 170, 180
Grade II	
Type 2	Parco Cleaners 341, 350, 371
Type 4	Parco Cleaners 250, 260
Type 5	Parco Cleaners 210, 220
Type 6	Parco Cleaners 100, 101, 110
U.S.A. 72-53	Bonderite 32, 34, 100, 125, 140, 160, 170, 180
U.S.A. 57-0-2	
Type II	
Class A & A1	Parco Lubrite 1 & 2
Class B	Parco Powder—Parco Compound
Class C	Bonderite 100, 125, 140, 160, 170, 180

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FIRST IN THE FIELD SINCE 1915

Book Reviews

and successful war leaders in the history of our country. This book will undoubtedly take its place among the classic military documents in the war annals of the United States.—DONALD ARMSTRONG.

The Army Air Forces in World War II. Volume II: Europe (January 1944 to May 1945). Edited by W. F. Craven and J. L. Cate. Chicago: University of Chicago Press. 948 pp. $8.50.

THIS is an important addition to the available published information on United States participation in the air war in Europe during World War II. However, the book shows a very glaring defect to an Ordnance reviewer. The very complete index at the end of the book does not contain the word "ordnance" as applied to U. S. Air Force equipment. Neither does the word "armament" appear in this index. Comparatively little mention is made in the body of the book concerning the weapons (guns and bombs, then Ordnance equipment) without which an air force is really a form of transportation.

Since World War II all nations have become bomb-minded to the point where they think of an air force not as a transportation corps for carrying people or cargo but as a deliverer of bombs. A history of World War II Air Force activities such as this one, which pays so little attention to the TNT types of bombs which were so important in the air phases of the war, must be considered incomplete. Perhaps this book illustrates an approach which is due to lack of close personal participation by the writers in the combat phases of the events described.

The history and development of air forces may be traced most clearly through studying the development of their weapons. Weapons determine tactics in modern war. Who at this time doubts the major effects of the atom bomb on the organization, equipment, and operations of air forces of the future? This reviewer, stationed in Europe, is continuously reminded of the effects of bombs every day of the week, whenever he drives out on the road.

Because this reviewer participated as the Chief Ordnance Officer of the U. S. Air Forces in the ETO in the events described, he has found many interesting things in the book. As a reference work it will be of much value to those who were concerned with World War II Air Force operations. It is of questionable value to those who want to understand Ordnance or weapons phases of the operations.—PHILIP SCHWARTZ.

The Railroads of the Confederacy. By Robert C. Black, III. Chapel Hill: University of North Carolina Press. 360 pp. $6.

THE author compiled this book primarily for his own needs. He had a long-time interest in both the Civil War and in railroading. When both were sharpened by three years' service in Georgia as an officer of the Army Transportation Corps he found that virtually nothing had been written to fill this obvious gap in military history. As the great American civil conflict was the first of the railroad wars, as it was the first of the rifle wars, the timeliness of such a study is patent.

Robert Black shows by exhaustive comparison that, despite the tremendous spurt of rail building in the decade preceding the Civil War, the Southern States were far more deficient in engines, cars, facilities, and supplies than indicated by their comparative mileage. Still graver was the low quality of the roadbeds, caused by financial difficulties and scanty traffic.

In manpower, they were better off. Native talent was intensely interested, and many Northern railroaders, attracted by gain or adventure, cast their lot with the seceding states. But besides the disadvantages in matériel, the Southern roads were appallingly unprogressive in interline coöperation. Even when the tracks connected (and there were many gaps), the use of

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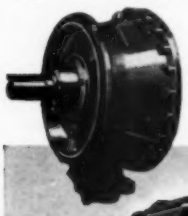

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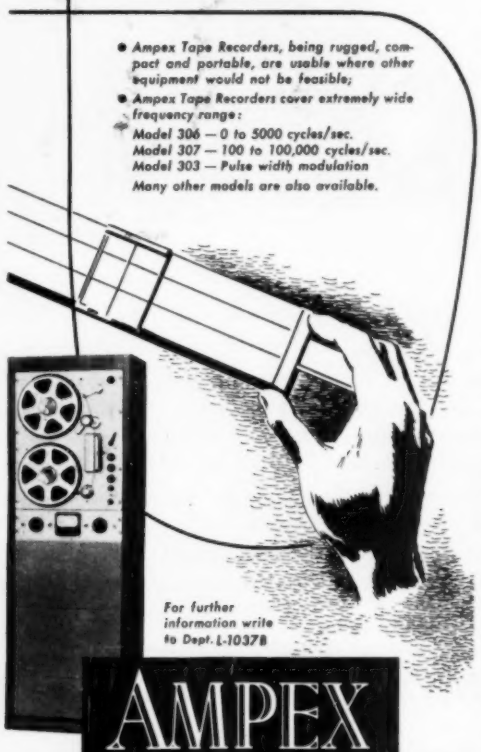

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each other's rails was the exception rather than the rule. Local ownership and local jealousy were the norm.

The author displays a sound appreciation of the importance of the greatest advantage held by the South—fighting upon interior lines—and of the immense role which the railroads could play in this factor of the war. These were many months ahead of most Southern facilities in their realization of the seriousness of the war, and consequently in their coöperation with war measures.

Very early, railroad companies had begun to make guns and other items for the Confederate Bureau of Ordnance. But the nemesis of Southern railroads, as of all Confederate war efforts, was the fetish of "States' rights" which dominated the thinking of many politicians and other ill-informed men.

Singularly fitted to evaluate wartime railroading, both by his interests and by his wartime experiences, Mr. Black has given us a quite complete and scholarly account of an important segment of military history. He writes in an objective and a factual style. The work is illustrated by numerous photographs and by many excellent maps. It is provided with forty-four pages of notes, a complete bibliography, and an index.

"Railroads of the Confederacy" will appeal to all who have an interest in military history and in railroads. But its real value lies in the fact that it is well-nigh the only serious modern study of the rail-transport phase of the Civil War. Its author has not only produced a book of interest, but has made a significant contribution to the study of warfare. Few military libraries can afford to be without it.—F. W. Foster Gleason.

Across the Space Frontier. Edited by Cornelius Ryan. New York: The Viking Press. 147 pp. $3.95.

THE symposium on the conquest and exploration of space, which recently appeared in *Collier's*, has been expanded in this book into a complete text on the subject. The tendency to scoff at proposals for the establishment of space stations beyond the atmospheric belt and to dismiss such planning as science-fiction is all too prevalent, but a perusal of this book will provoke affirmative thinking and in many cases will convert the unconvinced.

The coauthors—Dr. Wernher von Braun, Dr. Fred L. Whipple, Dr. Joseph Kaplan, Dr. Heinz Haber, Willy Ley, and Oscar Schachter, are recognized authorities in this field, and each covers his particular specialty. The legal question—"Who owns the universe?"—is handled by Oscar Schachter, who parallels the celestial domain with the maritime area and concludes that the problems are similar.

The question of man's survival in space, when subjected to the rigorous and synthetic conditions there, is ably discussed by Dr. Haber. He leaves the reader with some misgivings, but challenges the crusading reader to take a chance, if offered, nevertheless.

The technical discussion is ably covered by Dr. Von Braun, and occupies over a third of the book. His calculations, observations, and conclusions are presented in language understandable by the nontechnical reader. He includes enough technical information in his discussion to make his conclusions plausible. As Dr. Von Braun is considered to be the foremost rocket engineer in the world today, his published writings are accepted as authoritative.

This treatise seems to be a prediction of things to come, and the reader is convinced that it may come sooner than we think.—Thomas K. Vincent.

Development of the Guided Missile. By Kenneth W. Gatland. New York: Philosophical Library. 133 pp. $3.75.

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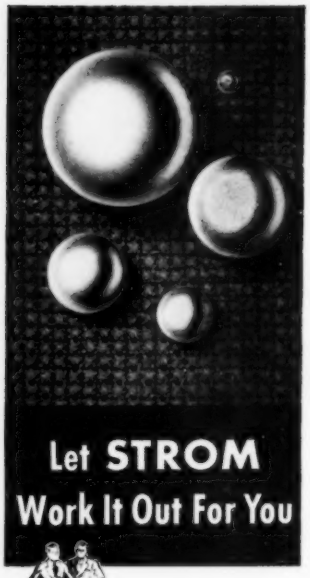

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Book Reviews

has gathered together a large amount of general and historical information on the subject of modern free-flight rockets and guided missiles; in fact, information is presented on a greater number of United States and foreign missiles than this reviewer has previously seen in any publication available to the public.

The author appears to be genuinely concerned over the danger of the United Kingdom to crippling attack by bombardment of rockets carrying atomic warheads and feels that British authorities do not fully appreciate the danger, the probability, or the disastrous consequences of such an attack by these weapons.

The author was, of course, handicapped by the security classification on missile weapons, but he presents as much information as he could obtain on American, German, British, and Swiss projects and, in the appendix, he tabulates the names and some of the principal characteristics of ninety different rocket and guided-missile projects.—BRIG. GEN. H. N. TOFTOY, *Director, Ordnance Missile Laboratories, Redstone Arsenal, Huntsville, Ala.*

They Fought With What They Had. By Walter D. Edmonds. Boston: Little, Brown & Company. 531 pp. $5.

ON December 8, 1941, we had 8,100 Air Corps troops and 1,500 Philippine Army Air Corps men in the Islands. But there were only 90 serviceable planes, mostly old models without replacement parts. When the news of Pearl Harbor came in, the pilots were eager to take off for an attack on Takao Harbor, Formosa, in order to lessen pressure from the impending Japanese fleet attack on the Islands. Brereton called Headquarters "again and again" for permission to take off. Colonel George begged Headquarters to put the thirty-five Fortresses, the heart of the Corps, into the air.

All requests for an attack were refused; headquarters was hepped on reconnaissance. When Lieutenant Bohucher broke out of the clouds at Legaspi directly over a Jap carrier with its planes neatly stacked on the deck, he circled over the ship without opposition but was under strict orders to observe and not to attack.

After the Jap bombing of the Philippines, the Air Force on Luzon had only seventeen planes that could be put into commission for flying, no oxygen for altitude flying, few repair parts, and a shortage of gasoline. The story of the gallantry and ingenuity of the shoestring air war that followed in the Islands makes one wonder how much more the Japs might have been slowed up if some one had realized that grand strategy is not applicable to a little group of second-rate planes and if the decisions for the shoestring war had been left in the hands of the officers on the fields.

We may have to fight with isolated small groups of planes in future emergencies, and every future air officer might profit from reading this book.—GEORGE STUART BRADY.

Radio Astronomy. By Bernard Lovell and J. A. Clegg. New York: John Wiley & Sons, Inc. 238 pp. $4.

MANY will recall the radio investigations of the moon by the U.S. Army Signal Corps in 1946 when echoes were obtained for the first time. The application of radio techniques to numerous other problems formerly in the domain of astronomy has led to a new science. This science of radio astronomy is very closely allied to astronomy, astrophysics, and physics in subject matter, but utilizes primarily the techniques of radio and radar.

This book, though in a new field of science, should be acceptable to a wide circle of readers. The first few chapters include an elementary introduction to fundamental astronomy as well as an introduction to some of the basic radio techniques involved.—JOHN J. DRISCOLL.

Mechanics, Part 1: Statics, 336 pp. Mechanics, Part 2: Dynamics, 665 pp. By J. L. Meriam. New York: John Wiley & Sons. $4 each.

THROUGHOUT both these volumes the time-honored cases are treated, but amongst them appear some of the newer and more spectacular of man's inventions. These should have an instant appeal to the student.

The writer was especially pleased to see an effort in the volume on dynamics to establish the concept of a primary inertial system for the laws of Newtonian mechanics. All too often in the past this idea has remained implicit in the teaching of elementary mechanics, with the result that the more advanced student is handicapped at the outset by the necessity of establishing the inertial frame as a basis for his thinking, instead of the more familiar Mother Earth, especially in the field of gyrodynamics.

The author might perhaps have gone further in this respect and instead of compromising on an astronomical frame of reference amongst the stars, proclaimed the inertial frame for what it is; namely a frame which neither rotates nor accelerates. Within such a frame the laws of Newton are valid.

Apart from this modest recommendation the writer has nothing but praise for Professor Meriam's substantial effort.—ARTHUR F. MACCONOCHIE, *head of the department of mechanical engineering, University of Virginia, Charlottesville, Va.*

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Book of the Month for January

FLEET ADMIRAL KING: A Naval Record

By Ernest J. King and Walter Muir Whitehill

No other man in history commanded so great a naval force as did Fleet Admiral Ernest J. King. Few men have had his clear, sure grasp of strategy. Now, spread upon the record, we have the career of the man who was probably the greatest Chief of Naval Operations we have ever had. His position, his attendance at all the major conferences, including Potsdam, his understanding of strategy and logistics, and the blunt uncompromising honesty and willingness to speak his mind that have been his lifelong characteristics make Admiral King's autobiography a book of major importance to every military man. Admiral King's career spanned 45 years, enabling the student to follow the development of the United States Navy from the turn of the century to the end of World War II, a fascinating study in itself. Retail, $6.75.

To Members, $6.08

RAILROADS OF THE CONFEDERACY

By Robert C. Black, III

The importance of a Nation's rails to survival and of a strong industry to keep them running is well shown in this record of the iron horse in the first of the railroad wars. Here is a contribution to military history that shows clearly how many current problems of wartime railroading parallel those of 90 years ago. Retail, $6.00. To members, $5.40.

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By Kenneth P. Williams

Here, in Volume III of Kenneth Williams' great history, is the full sweep and scope of the first year of the War in the West—from the beginning to the capture of Forts Henry and Donelson and the Battle of Shiloh. Here Grant appears and begins his development as a commander and strategist. "Lincoln Finds A General" is magnificent Civil War history that Bernard de Voto has called ". . . as close to being final as we are likely ever to get." Retail, $7.50.

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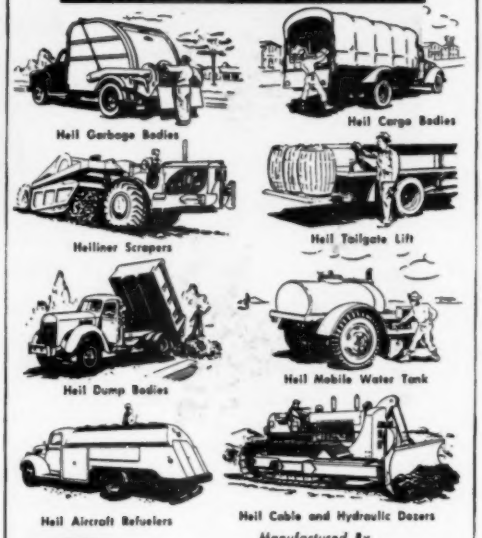

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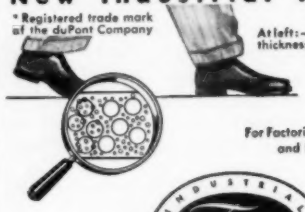

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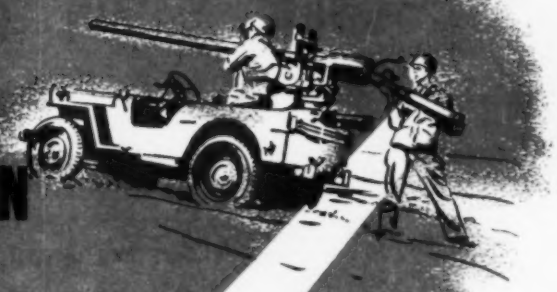

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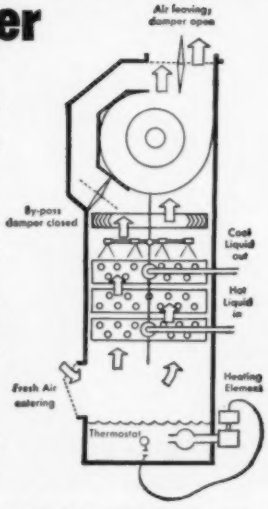

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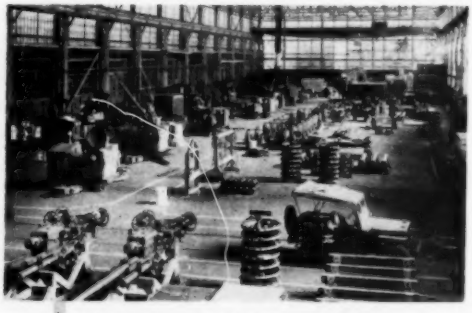

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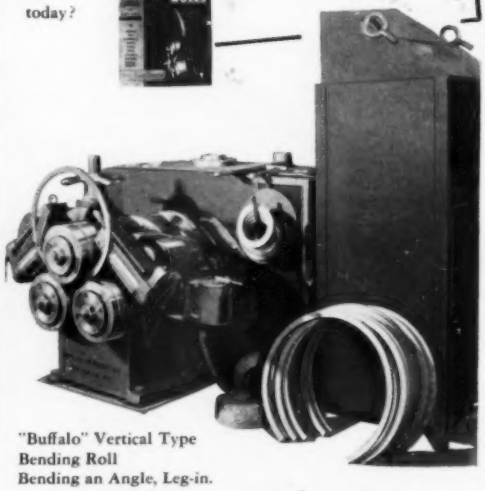

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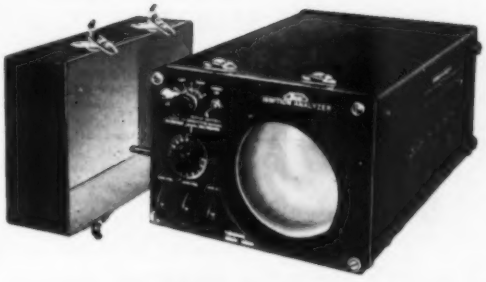

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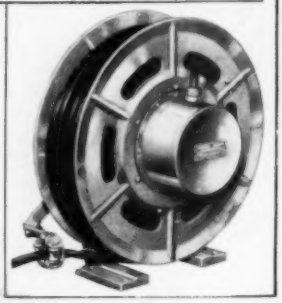

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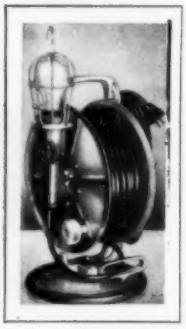

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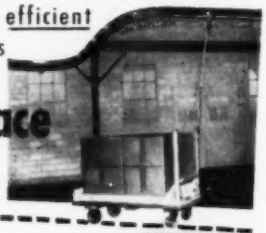

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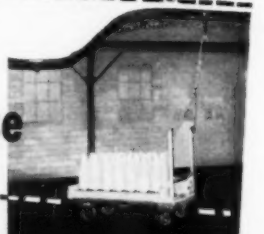

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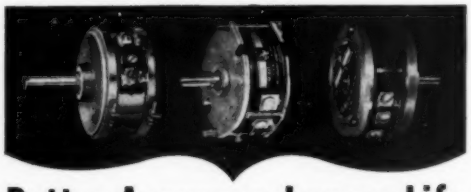

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ARMAMENT TECHNOLOGY

This section of ORDNANCE contains articles of a detailed and technical nature on ordnance research, development, manufacture, field use, and related subjects.

Captive Flight Testing

Firing Missiles on Tracks Aids Aërodynamic Research

Dr. Albert G. Hoyem

Head, Analysis and Reports Branch, Aviation Ordnance Department, Naval Ordnance Test Station, Inyokern, Calif.

THE fabulous Naval Ordnance Test Station at Inyokern, Calif., has been referred to as the Navy's "Land of Oz." Here the "Tiny Tim," the "Holy Moses," the "Mighty Mouse," and the "Ram" rockets first tried their fins, and many other creations with fantastic names haunt the place.

Well-Equipped Center

Situated on the northwest edge of the Mojave Desert, near the southern tip of the Sierra Nevadas, this arm of the Navy has in less than ten years grown from a group of scattered Quonset huts into one of the best-equipped rocket-development and test centers in the world. Surrounded by vast relatively unpopulated areas and favored with clear skies, it is ideally suited to testing activities requiring outdoor expanse and precise photographic coverage.

The station's roster is largely civilian and includes ranking names in the scientific and technological field. It also boasts numerous budding scientists and engineers who have been recruited during the past few years from the universities and graduate schools of this country. These are members of a well-planned training program which has been established to insure continued high-level participation of the station in the Nation's defense effort.

In addition to the excellent research laboratories and test ranges which grace this station, the Navy has established a modern city of air-conditioned homes and shops within the station's boundaries. A fine school system including a fully accredited high school has also been provided as well as a great variety of recreational facilities to satisfy the population's needs. It suffices to say that those who come to give it a try remain to make this place their home.

One of the station's most active test facilities is the Baker-4 Track, an unimposing 2-mile length of standard-gauge railroad track on which test vehicles are accelerated to high speeds by rocket propulsion and are then gradually brought to rest intact. This B-4 Track, operated by the station's Aviation Ordnance Department, serves three prime functions.

In captive preflight testing of guided missiles, rocket launchers, and related ordnance and aircraft components, it subjects test specimens to high accelerations and large aërodynamic forces. Significantly, the test specimen is recoverable intact at the end of the run after undergoing decelerating forces which are within the control of the test conductor.

Aids Design Engineer

This type of testing places events occurring at supersonic speeds within easy reach of the precision measurement possible with ground-located instruments and enables the design engineer to study the operational performance of an item without risking the loss of the missile or the aircraft whose flight may be directly dependent upon it.

The B-4 track also helps to determine the effect of wind or of target motion in the computation of the lead required to score a hit with a missile fired from an attacking aircraft. Gasoline-propelled carriages are used to simulate problems presented by wind or by tank, truck, or similar low-speed targets while rocket-propelled carriages simulate those posed

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William S. Lawrence

by high-speed targets such as jet aircraft.

The third use currently being made of the B-4 Track is to study the effect of cross-wind firing upon the trajectories of rockets and missiles. This is done by firing the rocket or missile from launchers set at an angle to the forward motion of the carriage.

The development of this test facility was begun in 1946. The guiding genius was Dr. William B. McLean, the present head of the Aviation Ordnance Department.

Others who played a major part in the development included Roy Leonard, who scoured the country in the procurement of the rails and ties and other basic materials; Harry McPherson, who has headed the aircraft ranges since the early days of the station; and John Lechner, the engineer directly in charge of operating and maintaining the facility.

Initial Purpose

The initial purpose was to provide controllable ground targets for testing the kinematic properties of lead-computing aircraft sights. The first targets were gasoline-propelled Buda cars which had a top speed of sixty miles an hour.

It immediately became apparent that higher speeds were needed for proper simulation of possible airborne targets. The search for means of attaining the necessary speeds led quickly to tests investigating rocket propulsion.

To minimize friction and jar, a 4-wheeled carriage equipped with flanged rubber tires was tried. It rode the rails only a short distance, then took off across the desert with its rocket motor still roaring!

A different carriage, consisting of simple crossarms mounted on magnesium-alloy shoes which gripped the rails, rode the track successfully.

The present vehicles are the outcome of numerous tests. One problem to be solved was how to construct a vehicle which would be subject to the minimum amount of retarding friction and which would have the maximum strength and the minimum weight. Another was to design a vehicle which would be able to transport a particular test specimen at required speed and at the same time not exceed the acceleration and deceleration limits set forth in the specifications for the test.

Current Vehicles

The vehicles currently in use range from simple crossbeam frames weighing less than a hundred pounds to massive structures weighing several tons.

The present track has three types of construction: concrete pier, crushed rock ballast, and compacted desert soil ballast. The concrete-pier section is 520 feet long and is located at the breech end of the track. The piers extend two feet above ground and are approximately eight feet apart. The rails are attached by means of specially designed clamps which allow precision alignment of the rails throughout this region of maximum acceleration.

The next section is the original one-mile of track, completed in March 1947. Here the rails are supported on wooden ties laid in rock ballast. The third and final section is 4,600 feet long. This section is also laid on wooden ties, but the ballast is simply compacted soil.

This section was added in 1950 to provide sufficient track length to bring certain high-speed vehicles to rest by action of air drag and rail friction.

As a precautionary measure, all vehicles are equipped with blades which deflect wet sand placed in ridges between the rails near the end of the track to insure stoppage should rail friction and air drag prove insufficient. The sand is of graduated depth to provide controlled negative acceleration.

Pusher Carriages Used

The velocity and acceleration requirements of the various tests are, in general, matched by varying the weight of the vehicle and the number and size of the propulsion units. Pusher carriages are resorted to when extremely high speeds are required or if the test specimen is massive. The use of a pusher carriage propelled by three Jatos to boost a test vehicle propelled by two Tiny Tims is not uncommon.

Velocities attained have ranged from 300 feet a second in the case of a 5,500-pound vehicle, to 1,400 feet a second with a vehicle weighing 300 pounds. The deceleration while the carriage is coasting freely ranges from six to eight times the acceleration of gravity for moderate-size carriages to as low as three times the acceleration of gravity for lightweight carriages.

The "nerve center" of operations is at the breech end of the track. Here are located photographic and electronic shops for on-the-spot repair and servicing of data-recording equipment; a machine shop for fabrication, modification, and repair of test vehicles; and the firing barricade for controlling the all-important operation of sending the vehicle on its way.

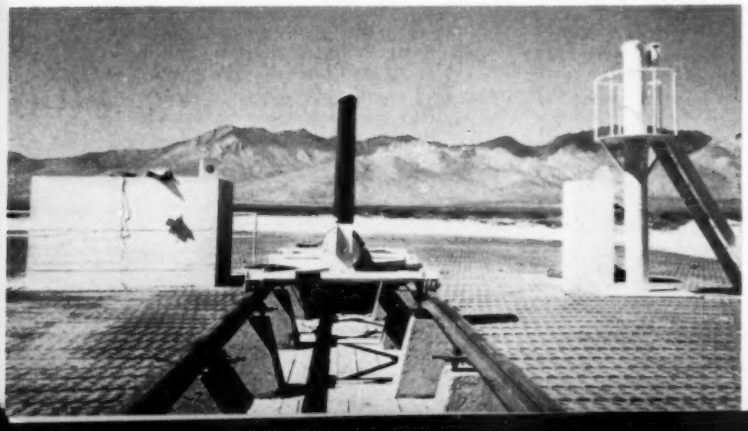
Operation Programed

The firing operation is carefully programed to avoid accident and to insure that all data-recording equipment is in readiness. A tenseness invariably creeps over the participants as the preparations are completed and the firing circuit is connected.

Frequently the programed warning signals—announcing that three minutes, two minutes, and, finally, one minute remains—are stopped as the test conductors decide to recheck the operation of a component or are notified that a remotely located camera is inoperative. Finally, the warnings sound again and there is further tenseness as the counting of minutes and seconds drones away.

At last there is a deafening roar as the vehicle accelerates and races down the track. Moments later a plume of

Ready for aërodynamics test, vehicle sits at breech end of Baker-4 track, Inyokern.



sand rises gracefully in the air as the sand brake goes into action to prevent the vehicle from sliding off the end of the rails.

Seeing such a firing impresses two points clearly; namely, that it takes the vehicle only a few seconds to traverse the length of this 2-mile track and that a highly significant event occurring in the course of the run may occupy only a few milliseconds or even microseconds. Great pains are therefore taken to make sure that all data records have an accurate and common time reference. And since no data-recording device is one hundred per cent reliable, it is standard practice to provide duplicate and even triplicate data coverage whenever feasible.

Test vehicle propelled by Jato unit and a Tiny Tim, and by two Tiny Tims on a pusher carriage, awaits firing on captive flight track at Naval Ordnance Test Station.

Many Cameras Used

The test specifications covering the tests on this track frequently read like stock lists of cameras because of the number and the variety of cameras called for. Bowen-Knapp cameras and Eastman high-speed cameras are standard requirements. These are augmented as needed by GSAP, Eyemo, and Mitchell cameras—some viewing a strategic portion of the track, others a particular component undergoing test.

In addition, there are oscillographs which record data telemetered from the vehicle and electrical impulses generated in coils along the track by a magnet mounted on the test vehicle. These latter signals, when compared with simultaneously recorded time traces, yield data on the position, velocity, and acceleration of the vehicle at any point of the run.

The magnetic pick-up coils are located twenty-five feet apart except at the breech end of the track where they are spaced two feet apart. The breech end is the region of highest acceleration. It is accordingly a region of great interest.

Numerous improvements to make this track facility even more useful are under way. These include extension of the present pier-type construction by 4,000 feet to provide a total track length of approximately 3 miles, transfer of the headquarters area to the new breech end, and erection of enlarged shop and operations-control buildings.

The present wooden-tie section is being strengthened by adding steel ties mounted on concrete posts sunk in the present roadbed. Great care is being taken to obtain precise alignment of the rails throughout, particularly where the highest accelerations and speeds will occur.

Marked improvements are also being made in the data-recording and data-synchronization systems. These will include recording of elapsed time to the closest one-millionth of a second.

The need for additional track length has been particularly evident in moving-target tests because of difficulties experienced in coördinating the rocket-propelled targets with the runs of the attacking aircraft. The additional one mile of track should greatly simplify this problem.

Higher Vehicle Speed

Another benefit which will be derived from the increased track length is higher vehicle speed. Stopping a high-speed vehicle within the length of the present track requires the use of sand. This imposes on the vehicle negative accelerations which may be destructive to the item under test.

To prevent such occurrence the test conductors much prefer having sufficient track length so that the vehicles can coast to rest, relying upon the sand only as an emergency brake to keep the vehicle from running off the track.

Improvements being made on the existing track are now nearing completion. The extension of the track and the construction of the new headquarters facilities are scheduled for completion by October 1953.

The B-4 Track is in constant demand since it is situated near the growing aircraft and defense industries of Southern California. Design engineers value it highly since it provides an opportunity to test the operating performance of components and systems in captive flight under conditions closely simulating those likely to be experienced in actual flight.

The alternative is to attempt to determine operational characteristics by recording performance data in flight or telemetering the information back to a ground station.

The aircraft and the guided-missile industry has ample documentary evidence of the tremendous waste of development effort, money, and human life which can result from waiting for the maiden flight of an aircraft or of a missile to determine whether a given component will perform satisfactorily under the accelerations and the aërodynamic forces imposed. That is why tracks of this type are an extremely worth-while investment.

Building New Track

The Naval Ordnance Test Station at Inyokern has long realized that a 3-mile track will not serve all needs. It is therefore in the process of building a higher precision track having greater length and capable of transporting massive vehicles traveling at speeds reaching far into the supersonic region.

Lightweight Body Armor

by
Ludlow King

Fiberglas-plastic-nylon combination saves numerous lives in Korea

Sniper's bullet is stopped by armored vest on a hospital corpsman in Korea.

"PFC. J. ARTHUR WICK of Port Jervis, N. Y., a member of K Company, 17th Infantry, U. S. Army, smothered a hand grenade with his body. The explosion threw him into the air, but he suffered nothing more serious than a bruised chest."

"Marine Pfc. Lee Ward, Maplewood, Mo., says the body armor is 'indispensable.' He said, 'On a patrol about a week ago, I had an enemy mortar shell land about ten feet away from me. I picked five pieces of shell fragments out of my vest. Didn't bother me. Another guy on the same patrol stopped six burp-gun slugs with his jacket. All he got out of it was a couple of bruises'."

Amazing Reports

Since last March, newspapers, magazines, radio, and television networks have brought us many amazing reports similar to those quoted above. The most important point of all the reports is that lives of our soldiers in Korea are being saved by a lightweight, modern body armor. However, within these stories lies another story that should be told at this time.

In the past there has been exaggerated criticism of the lack of coöperation between our departments of national defense. This story is a living example of the splendid coöperation, interchange of information, and integration of efforts on the part of the U. S. Army, Navy, and the Marine Corps in the development of superior instruments of warfare. It is one in which we can all take a great deal of pride; members of the Defense Department, members of industry, and taxpayers alike.

"Standarized" Armor

It pertains to the development and use of a new nonmetallic armor—a highly engineered and designed combination of Fiberglas cloth and plastics. Several communiques have erroneously referred to other types of armor plate being used in Korea. The only "standarized" body armor being used in Korea in combat today is made ninety per cent of the Fiberglas-plastic combination, best known as "Doron," which is used to protect the body, and ten per cent of nylon which is used over the shoulders.

In 1942 a shortage of metallic armor established an urgent requirement for the development and production of a new nonmetallic armor. Research and development people throughout our military departments accepted this challenge with zeal and determination.

General Doriot

In June of that year, Brig. Gen. Georges F. Doriot, for whom the combination Fiberglas-plastic armor was later named, was serving as chief of the Military Planning Division, Office of the Quartermaster General, U.S. Army. He directed his division to investigate the possibilities of combining a comparatively new fibrous glass material with plastics in an effort to produce a new lightweight nonmetallic armor.

The Quartermaster General invited the Naval Research Laboratory, which had been working on a light armor program for aircraft applications, to coördinate their work with the Quartermaster Corps. The Naval Research Laboratory's objective, at that time, was to develop a light armor plate to use in the place of manganese steel which was considered too heavy.

Colonel King, president of the Washington Post of the A.O.A., served as corps Chemical officer under Gen. J. Lawton Collins during the invasion of Normandy in World War II.

Edwin Hobson, chief of the Plastics Section in General Doriot's division, immediately called in members of industry to get full particulars of the new technologies developed in the field of reënforcing plastics with high-tensile-strength fibrous glass. Army Ordnance had already developed the theory that high ballistic properties could best be obtained from materials possessing high strength and ductility. Mr. Hobson won the complete support of industry and encouraged them to carry on further experiments.

The Birth of Doron

In May 1943, the Dow Chemical Company laminated a fibrous glass fabric and plastic in a special manner which provided encouraging ballistic values. This was the birth of Doron. Meeting this initial success, the Army Quartermaster Corps was authorized to intensify its research program. It established projects with industry to investigate thoroughly the bonding properties of all resins, the production of high-strength glass filaments, the best types of fabric weaves to provide greater strengths, and the lamination and fabrication processes to provide optimum results.

Some of the companies participating in the early phases of this development work were General Electric, Dow Chemical, Hercules Powder, American Cyanamid, Bakelite, Monsanto, Firestone, Westinghouse, Formica, Continental Diamond, and United States Rubber. The willingness of all these companies to pool their efforts in one single military program is indicative of the genuine spirit of coöperation developed between the military and industry during World War II.

Industry-Military Team

It was during this period that industry as a whole started thinking of the military as "our Navy," "our Army," "our Marines," "our Air Force." Industry learned for the first time they actually are a part of our military and that the military is a part of industry. In this shrinking world of ours, they are completely dependent one upon the other and inseparable as far as the defense of our country is concerned.

Later a joint committee on nonmetallic armor was created by the Defense Department. This was composed of members from the Office of the Army Quartermaster General, Naval Research Laboratory, Bureau of Ships, Army Ordnance, the Bureau of Medicine and Surgery, and the Bureau of Aëronautics. The control of this committee was vested in the Office of the Quartermaster General of the Army.

"The joint efforts of the military and participating companies of industry have been more than rewarded by the knowledge that these body-armor jackets will return many of our soldiers to their families who otherwise would have been listed 'lost in combat'."

Dr. G. R. Irwin of the Naval Research Laboratory and Mr. Hobson designed and developed a complete body-armor jacket utilizing Doron armor plate. Two officers of the Bureau of Medicine and Surgery staged demonstrations at Camp Lejeune, Quantico, and the FBI Barracks. The demonstrations were made by Lieut. Comdr. Andrew Paul Webster, U.S.N.R., who fired a caliber .45 automatic pistol at his friend, Lieut. Comdr. Lyman Corey, U.S.N.R., who was wearing an armor jacket. This was perhaps the first protection given to humans by Doron.

Battalion Equipped

As a result of these demonstrations and complete data and statistics furnished by the Quartermaster General of the Army, the Marine Corps obtained appropriations to equip a full battalion with this body armor for landing operations. Doron panels were sewn into standard utility jackets and first used in the last stages of Okinawa in 1944. At the same time, recommendations were made by the Navy to procure 300,000 life jackets with added panels of Doron for use in landing operations. At the close of World War II, the importance of body armor jackets greatly declined.

In 1948 the Marine Corps established a Body Armor Section under the Medical Research Laboratory at Camp Lejeune. This was directed by Lieut. Comdr. Fred L. Lewis, Jr. His principal objective was to coördinate with the Office of the Quartermaster General and the Naval Research Laboratory in determining which nonmetallic body-armor materials were most suitable. Upon the selection of Doron, he then designed a vest using curved plates instead of the flat plates formerly used. These curved plates enabled the vests to conform with the contours of the body.

Forty Vests Made

In the spring of 1951, forty vests were made of curved Doron panels, procured by the Quartermaster General of the Army and assembled into vests by the Marine Corps in Philadelphia. These vests were combat-tested in Korea under the auspices of the Marine Corps, the Army Quartermaster Corps, the Navy Bureau of Medicine and Surgery, and Army Ordnance. By November 16, 1951, the Marine Corps had established requirements for body-armor vests due to the stabilization of warfare in Korea and placed an order for 2,000 of the protective garments.

Rushed to Korea

The first 500 were air-shipped to Korea on January 30, 1952. These were used in combat on February 21, 1952. A Marine Corps team observed the tremendously successful performance of these vests and recommended additional procurement to outfit the entire 1st Marine Division. The United States Army established requirements for body-armor jackets, and the Marine Corps assisted in the procurement of jackets for the Army.

The joint efforts of the military and participating companies of industry have been more than rewarded by the knowledge that these body-armor jackets will return many of our soldiers to their families who otherwise would have been listed "lost in combat." As of this writing approximately 80,000 to 90,000 Doron jackets have been procured for use in Korea.

Second Application

It is interesting to note that this is the second application of glass in fibrous form which is saving the lives of our men in the military. The U. S. Navy's "standard" life jackets are now filled with fine fibrous glass in wool form, treated with water-repellent silicone. This has been found superior to cork and Kapoc for long-life buoyancy properties.

Army Ordnance photo

Conserving Strategic Alloys in Armor Plate

World War II Shortages Forced Development of Boron Steels

by

Abraham Hurlich

THE rearmament of the United States which was made imperative by the world events of 1939-1940 required the production of large quantities of armored vehicles. It was realized that the few facilities which were then available for the production of rolled and cast armor would be unable to manufacture the large quantity of armor required for the military program.

Subcommittees Organized

Accordingly, the Chief of Ordnance requested the Ferrous Metallurgical Advisory Board, centered at Watertown Arsenal, Watertown, Mass., to organize subcommittees on cast and rolled armor for the purpose of accumulating and interchanging technical data on the development and production of armor.

The subcommittees also were to advise on specification requirements and production problems, to assist new manufacturers to enter into the production of armor, and to assist in the production of the best possible quality of armor in the amounts required and with the raw materials, equipment, and operating personnel which could be made available.

The Subcommittee for Cast Armor was organized in September 1940 under the chairmanship of Col. H. H. Zornig, director of the Watertown Arsenal Laboratory. It consisted of technical representatives of seven cast armor producers, who at that time had knowledge and experience in the manufacture of cast armor, as well as representatives of the Army Ordnance Corps and the Navy Bureau of Ordnance.

The membership increased as new producers entered the field until, in 1943, the maximum membership consisted of representatives of thirty-three cast armor producers, eighteen military establishments, one producer located in an allied country, and three government agencies of allied countries.

Group Increased

The Subcommittee for Rolled Armor was also organized under the chairmanship of Colonel Zornig in October 1940. This group grew during the war years from its original membership of technical representatives from six rolled armor producers and four military establishments to representatives from one foreign and twenty-five domestic steel producers, twenty-five Government agencies, and two allied countries.

Until 1940 the limited quantities of rolled and cast armor which had been produced for armored vehicles were made from high-alloy steels containing a total of six per cent or more by weight of strategic alloying elements such as nickel, chromium, molybdenum, and vanadium.

Tank-Armor Steels

Between World War I and 1940 the most commonly employed tank-armor steels consisted of nickel-chromium, nickel-molybdenum, nickel-chromium-molybdenum, chromium-molybdenum-vanadium, and nickel-molybdenum-vanadium alloys containing up to 5 per cent nickel, 2 per cent chromium, 1 per cent molybdenum, and 0.30 per cent vanadium. Most of these steels were hardened by oil-quenching, although water-quenching and even air-hardening treatments were employed to a limited extent.

Limited Conservation

During 1941 a limited effort was made toward conservation of the more critical alloying elements. This effort was largely confined to substituting chromium for some of the nickel content of high nickel steels and a slight lowering of the molybdenum content. The Watertown Arsenal Laboratory, anticipating the shortage of alloys for armor in time of emergency, preceded the armor industry in the development

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of low-alloy steels for homogeneous tank armor.

By November 1941 the Watertown Arsenal Laboratory had developed a manganese-molybdenum steel which met the ballistic requirements specified for 1½-inch rolled homogeneous armor. In this composition, the relatively nonstrategic alloying element manganese was increased to approximately 1.5 per cent, permitting the complete elimination of nickel and chromium.

Protecting Stock Piles

Early in 1942, the tremendous demand for alloy steel arising from the huge production of military equipment, both actual and being scheduled, necessitated the institution of conservation methods to prevent the exhaustion of the national stock piles of strategic metals.

In February 1942, special meetings of the Subcommittees for Rolled and for Cast Armor were called at the request of the Chief of Ordnance, and representatives of the War Production Board outlined the expected scarcities of nickel, chromium, and vanadium for use in armor. It was indicated that steel armor compositions containing a maximum of 0.60 per cent nickel, 0.60 per cent chromium, and no vanadium must be developed.

Within less than two weeks the industrial members of the armor subcommittees held meetings to decide upon experimental programs designed to investigate a number of promising low-alloy armor compositions. The compositions chosen were based upon the alloy restrictions and upon the small amount of data on low-alloy steels which had been obtained at the Watertown Arsenal and by some of the armor producers.

Manganese Content Raised

The manganese-molybdenum steel which had been developed by the Watertown Arsenal Laboratory was included in the series of low-alloy steels, as were a number of other compositions in which the manganese content was raised to levels in the range of one to two per cent and the nickel and chromium content reduced to less than one per cent of each element.

The burden of preparing experimental heats of these low-alloy steels was distributed among the several companies then making cast and rolled armor. Each company concentrated upon the particular compositions most adaptable to its processing equipment and methods, with special attention devoted to the conservation of alloys recharged into the furnace as scrap for remelting.

During March and April 1942, several hundred test plates of low-alloy cast and rolled armor steels were shipped to Aberdeen Proving Ground for ballistic testing. These plates were tested immediately upon receipt at the proving ground, and records of their chemistry, processing, and ballistic performance were sent to the Watertown Arsenal for tabulation and distribution to members of the armor subcommittees.

"During World War II the rolled-steel industry perfected deoxidation and 'needling' practices, most of which involved the element boron which resulted in the production of steels of enhanced hardenability."

Sections of the ballistic test plates were also forwarded to the Watertown Arsenal for postballistic metallurgical examination and correlation of their mechanical, metallurgical, and ballistic characteristics. In this way the producers were kept informed of the compositions which were giving the greatest success and could alter their plans accordingly.

Quick Change-over

As a result of this program, the entire change-over in production from the high-alloy types to the low-alloy types of cast and rolled homogeneous tank armor was made within the short space of six months. This performance is particularly creditable when it is realized that during this same period great emphasis was being placed upon meeting heavy production schedules and the severity of the ballistic specification requirements was being increased by the introduction of ballistic shock tests designed to assure satisfactory performance of armor at low temperatures and under severe conditions of ballistic shock attack.

The hardening heat treatment applied to the high-alloy cast and rolled armor compositions generally involved quenching in oil. When the low-alloy armor compositions were developed, the armor manufacturers were obligated, perforce, to resort to water quenching because the lower hardenabilities of the low-alloy steels demanded more drastic quenching treatments for full hardening.

A Signal Advance

In the case of the cast steel industry, the installation of elaborate heat-treating equipment and the development of successful heat-treating procedures for castings of complicated shapes represented a signal advance in that industry; an advance which, if not forced by the urgencies of war, would probably have required an additional ten to fifteen years for its occurrence.

Prior to World War II, steel castings, when heat-treated at all, were either annealed (furnace-cooled from elevated temperatures) or normalized (air-cooled from elevated temperatures) and tempered. These latter treatments were conducted generally for the purpose of stress-relieving castings or to improve their machinability.

The widespread application of heat treatment to improve the physical properties of steel castings to meet exacting specification requirements is a development entirely traceable to the recent war. The cast steel industry performed a task of heroic proportions when it geared itself for the production of the thousands upon thousands of tons of cast armor which were required by the tank program during World War II.

In the case of the rolled armor industry, major strides were made in the development of continuous heat-treating equipment into which normalized steel plates entered at one end and emerged from the other in the fully hardened and tempered condition. The widespread adoption of big-end-up ingot molds and improvements in hot-topping practices permitted increased yields of high-quality steel suitable for use as armor.

Quenching Equipment

The development of die-quenching equipment in which armor plates may be quench-hardened by water spray while being firmly gripped between platens permitted the production of

large armor sections completely free of warpage and distortion.

A correlation of metallurgical and ballistic data accumulated during the period in which the low-alloy armor compositions were being developed indicated that armor made from all the successful compositions which were investigated had comparable ballistic properties provided the armor was fully hardened upon heat treatment so that the final microstructure was essentially tempered martensite. It was also found that when the alloy content was insufficient to provide hardenability adequate to result in full hardening, the armor generally displayed poor ballistic performance.

Comparison of the ballistic properties of the new low-alloy armor steels and the former high-alloy steels demonstrated that the reduction in alloy content produced no perceptible change in the ballistic characteristics of the armor.

As a matter of fact, the inclusion of new ballistic shock test requirements in the armor specifications resulted in the improvement in the metallurgical and ballistic properties of armor since they highlighted the necessity for complete quench-hardening of armor.

Introduction of Boron

A major contribution was made to the conservation of strategic alloys by the introduction and widespread use of boron to enhance the hardenability of armor compositions. Many articles have appeared lately in the steel trade journals and even in technical publications which stress the recent growth of industrial applications of boron-treated steels.

It does not appear to be recognized generally that several hundred thousand tons of boron-treated low-alloy steels were made and used as armor during the period 1942-1945. As a matter of fact, by April 1943 every major producer of rolled homogeneous tank armor was employing boron in the production of armor steels.

New Techniques

During World War II the rolled steel industry perfected deoxidation and "needling" practices, most of which involved the element boron in one form or another, which resulted in the production of steels of enhanced hardenability as compared with steels of similar alloy content which are not so treated.

Only a few producers of cast armor were able to develop commercially practicable techniques for using boron to increase the hardenability of cast armor steels. This was probably traceable to the fact that the relatively small and variable sizes of cast armor heats made it difficult always to control the deoxidation procedure which must be effectively performed if the hardenability effect of boron additions is to be realized.

Also, the fading or gradual loss of the effect of boron upon hardenability during the pouring of castings made it difficult effectively to control the use of boron in steel foundries.

"The fact that thousands of armored vehicles were successfully fabricated by welding demonstrates that boron-treated steels are weldable by commercially practicable methods."

Nevertheless, a number of foundries did successfully melt boron-treated low-alloy cast armor steels during World War II. Continuing effort is being directed to the solution of foundry problems so that boron can be more extensively used in cast low-alloy steels to effect further conservation of alloys in cast armor.

The manganese-molybdenum composition which had been developed by the Watertown Arsenal Laboratory underwent further development by industry, and this composition, modified by the addition of boron to increase its hardenability and to provide a more uniform response to heat treatment, was adopted by several rolled armor producers and was used throughout the war.

Huge tonnages of the Mn-Mo boron-treated steel were made in all thicknesses up through 3-inch rolled armor. Cast armor producers modified the Mn-Mo composition by the addition of 0.50 per cent chromium in place of the boron used by the rolled armor producers, and large tonnages of the Mn-Cr-Mo cast armor steel were produced.

Large tonnages of a boron-treated low-alloy manganese-silicon-chromium-molybdenum-zirconium steel were also produced, primarily for the lighter gages of rolled tank armor. This alloy was developed by one of the major industrial producers of rolled armor and employed very small amounts of the more strategic alloying elements, chromium and molybdenum.

Commercially Practicable

The fact that thousands of armored vehicles were successfully fabricated by welding demonstrates that boron-treated steels are weldable by commercially practicable methods. The weldability of boron-treated steels had often been questioned, but the tank production program during World War II stands as irrefutable proof that steels bearing boron are readily weldable.

As a matter of fact, the development of low-alloy tank armor steels was what made the welding of tanks possible since many of the former high-alloy armor compositions could not be welded without a considerable amount of preheating.

It was found possible to substitute boron for some of the molybdenum of armor steels without loss in hardenability. The molybdenum content of some armor steels could be reduced from 0.50 per cent to amounts in the range of 0.20 to 0.30 per cent without danger of excessive embrittlement.

Boron for High Strength

In view of the fact that boron is one of the very few alloying elements which promotes hardenability without increasing the susceptibility to temper brittleness, this element is very attractive for use in applications requiring high strength and high toughness.

The outstanding development accomplishments of industry and Ordnance, outlined here, made possible the conservation of tremendous quantities of critical materials. However, as was to be expected, this development was not reflected in every ton of armor produced. Further, as the war drew to a close, the urgency of the problem lessened.

As a consequence, some producers did not complete the conversion to the newer practices, since the change-over in many cases was a huge undertaking.

Today we again find an opportunity to continue and extend the World War II program until all armor producers utilize the minimum of critical alloys while at the same time producing armor with superior ballistic qualities.

Army photo

Ordnance Salvage in Korea

Time, Money, and Equipment Are Saved by Unique Operation

Lieut. William D. Hall

Public Relations Officer with the 2nd Logistical Command in Korea

MASAN, KOREA, a dot on a map of the world, is the location of an Ordnance operation which is unique in the history of logistical supply. Pronounced "Mah-san," the little city is fifty miles west of Pusan on the mountainous South Korean coast and has a fine, protected harbor. Flanked by thousands of rice paddies, Masan was once a prosperous grain center and is still a busy agricultural community. But in the center of this area is an operation which is saving the people of the United States millions of dollars.

First of Its Kind

February 1951 saw an Army Ordnance unit leave the States which was the first unit of its kind to venture into the Far East. Organized as a reclamation and classification unit, it was sent to Korea with the express mission of establishing a central salvage point for the offal of the Korean battlefields. Regardless of its nationality, it was essential to the economy of our country that each piece of equipment that could be found any place under United Nations' control be systematically evacuated to a central point.

Ideal Place

After operating in the Pusan area for a short time during the precarious perimeter days, the operation moved to Masan in June 1951. With its docksite and berthing facilities, Masan was an ideal place. As a southern terminal of the efficient Korean railway system, rail cars could be rolled into Masan on a regular schedule. Here, precious matériel could be identified, classified, and placed in recovery channels. The installation is doing just that today. The "Honest Sam" junkyard has become the "Uncle Sam Reclamation Depot."

The move to stop further damage to unserviceable Ordnance items is begun very near the front lines and consists of an initial segregation and boxing. To examine the heavily loaded cars as they arrive at the Masan Depot is indeed a revelation. Boxed items and assemblies which would be damaged by weather while in transit are packed in boxcars, while other items are shipped in gondola cars. Shot-up, burned-out tanks and vehicles are shipped on flatcars.

Efficiency Increased

After cars are brought into Masan the meticulous work of separating the unserviceable items from the accompanying scrap is begun. As the efficiency of the operation has increased, the number of Korean workers has decreased until only 8,000 are now employed. Previously, twice that many were needed. Directed by American personnel, the Koreans have become very efficient in this type of operation.

Casting a quick glance at a high-sided flatcar one can see a multitude

of items including tank transmissions, engines, sprockets, truck bows and seats, thousands of small arms, and miscellaneous items. Precious radiators, generators, and carburetors are received, boxed, and crated to prevent damage. These packages will be opened and their contents processed later.

Shipped Under Cover

All American small arms are partially boxed and are shipped under cover. On the flatcars one sees tanks, trucks, jeeps, artillery tubes, and complete artillery. The trains are completely unloaded on the car-level platform. Tons of cartridge brass and steel ammunition containers are unloaded at a separate quayway of the depot where these items can be easily reloaded onto waiting ships.

Let's take a few items and follow them through the processing which they receive. A tank which has struck a mine is lifted from its flatcar and placed on the large loading platform where the gasoline is drained from it and where it is carefully checked for any live rounds of ammunition. Often one or both tracks are missing, but you can be sure that they are someplace in the flotsam of the yard. Guns and fire-control instruments have previously been removed.

Then our tank, still worth thousands of dollars, is towed to a point on the quay where it is placed aboard a barge for midstream loading onto a waiting freighter. The barges used can accommodate seven or eight tanks at one load. It is not unusual to handle 12,000 measurement tons of combat vehicles a month in this manner.

Tires Salvaged

General-purpose vehicles such as the 2½-ton truck are handled quite differently. Many of them are received loaded with tires, and every pound of this rubber is saved. The vehicle keeps only what tires are required to roll it to the edge of the pier for loading; the balance are stacked awaiting classification. Gasoline is drained from the truck's tank, and the vehicle is carefully checked for any live ammunition. Then it is towed by a wrecker to its loading point. To make sure that it is not put aboard a freighter while still containing gasoline or ammunition, the truck is checked again by a final inspector who marks it "ready for shipment."

All vehicles of this type are returned to Japan where they are rebuilt for reissue. It should be said that thousands of the vehicles thus being processed originated in "Operation Roll-Up" and had spent some years on a South Pacific island prior to being put into the Korean war effort. Many vehicles have returned to the Korean front several times after being "consumed" by war and rebuilt in Japan. Since 60,000 measurement tons of this type of vehicle are sometimes handled each month, the savings are in the millions.

Major assemblies, engines, transmissions, and radiators are separated and carefully boxed for loading and shipment, each labeled with full identification. Every effort is made to assure safe arrival of these units in Japan and that no further damage is done to them.

Lead Recovered

All batteries which can be put back into service with minor repairs are crated for shipment to Japan. Others are salvaged on the spot, and this is one procedure which deserves our attention. The batteries are opened and the contents removed. The grids are separated and beaten by hand with a steel strap to remove all lead sulphate. All lead is placed in a cauldron and melted down. Cast into ingots, it is stored for return to the United States. Tons of hard-to-get lead are recovered in this way.

We have mentioned tires previously. They are carefully inspected at Masan, and many of them are classified for immediate reissue in Korea. The saving here is tremendous. Those tires and tubes beyond repair become salvage rubber and are sent to Japan.

Weapons of all types, both American and captured enemy, are brought into Masan. Immediately upon receipt they are stacked into piles to be processed. Assembly-line methods are used with Korean labor. After proper training, young Korean women become very proficient in the disassembly and cleaning of small arms. Captured enemy weapons are handled on a separate assembly line.

After a thorough stripping, cleaning, and reassembly, all units are cosmolined and boxed for shipment to Japan. The items included in these shipments are rifles, machine guns, mortars, antitank guns, and even bayonets.

It should be stated that a technical intelligence team is in residence at the depot to catalogue the characteristics of foreign matériel. Thousands of foreign weapons have been evacuated to the United States for test and evaluation.

Personnel Meticulous

No part is too small to receive the attention of the workers at Masan, and the American personnel directing the work are meticulous in their instructions. A sense of the value of their efforts is apparent in all sections.

Cartridge brass and steel ammunition containers are loaded in separate cars near the front and are shunted into the brass yard at Masan. Every scrap of these precious metals is picked up for shipment to the rear. Unloaded by Korean indigenous personnel, mostly women, the material is piled in mountainous stacks. Some separation by calibers is undertaken to facilitate space saving aboard ship.

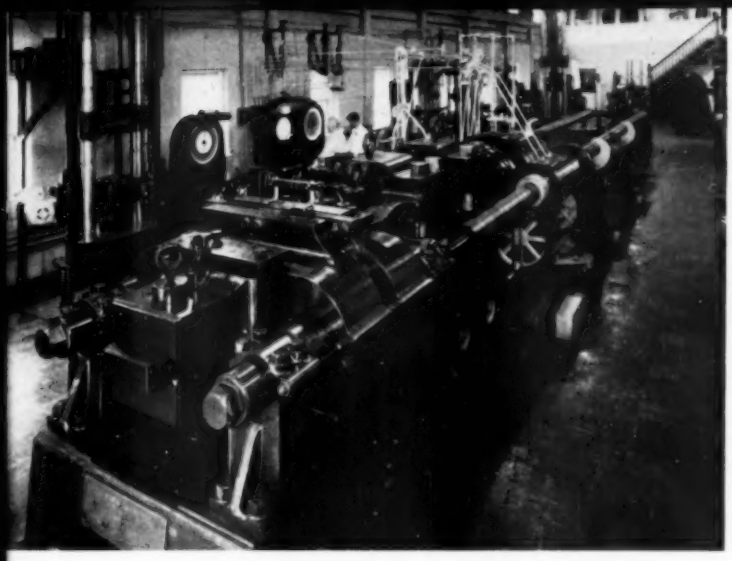
The Korean "A" frame is used by the Koreans to carry the metal to a segregation point and eventually to the cargo nets for ship loading. The front of the brass yard at Masan is used to load vehicles and major items other than tanks directly into the holds of a ship. Brass and steel ammunition container shipments averaged over 12,000 measurement tons for the first three months of 1952, and this is far below peak operation.

Over 140 Americans make up the Ordnance unit operating at Masan. Each man operates his section with the inborn skill of American soldiers everywhere.

Take a good location, with adequate docking facilities and rail connections, add a skilled group of technicians and a malleable force of Korean workers, and you have a reclamation effort in Korea of which all Americans can be proud.

Every Pound Saved

There are many opinions on how much American economy can stand in a continued war effort. As wasteful as war is known to be, it is the type of activity carried on at Masan which helps us save every pound of our valuable metal economy plus the items which are still in reparable condition and the attendant saving in long overwater transportation.



United States Testing Machine

Old Device Takes a New Lease on Life

TODAY at the Watertown Arsenal, Watertown, Mass., a 72-year-old testing machine of a million pounds' load capacity, the first to have both hydraulic loading and independent hydraulic load transmission to balance scales, is entering the second phase of its long life.

The "United States Testing Machine," as it was long known, has been rejuvenated by four new Emery hydraulic load cells of latest design and a new Tate-Emery control system with 3-range load indicator dial, shown in the illustration above. The electric-motor-driven oil pump in the control cabinet replaced accumulator-type hydraulic equipment occupying 200 square feet of floor space.

Automatic Indicator

With these accessories, operation of the old testing machine is nearly identical with that of the seven Baldwin testing machines of smaller capacity which have been installed in the laboratory during the past eleven years. Loads are now automatically indicated on a large dial instead of being determined by a slow, manually balanced lever system, and load changes are followed instantly under changing load conditions.

Symbol of Achievement

To Watertown Arsenal engineers the famous testing machine is a symbol of outstanding laboratory achievements dating back as far as 1830 when the laboratory activities began. First metallurgical work was done there in connection with improvement of cast iron and cast-iron cannon. During the 1840's cast-iron cannon developed at Watertown Arsenal were reputedly the envy of the world.

In the 1870's steel began to emerge as a competitor of cast iron for gun construction. To enable thorough study of the properties of American iron and steel, Congress appropriated funds for construction of a testing machine with specifications of "unheard-of rigidity." A. H. Emery was given the contract to design and build the machine, large enough to accept compression specimens up to thirty feet long.

Exceeded Specifications

In spite of the rigidity of the specifications, a report to Congress dated June 30, 1879, reveals that "the machine is more perfect than we [a special board appointed by Congress] had any right to expect from the terms of the contract." The contract price of $31,500 was about half the actual cost to the contractor. For this reason, the report continues, "the board is of the opinion that the Government should, under the circumstances, come to the relief of Mr. Emery and not allow him to suffer so severely for his unusual devotion to its interest."

Even the President of the United States, Rutherford B. Hayes, recognized the importance of the machine in a message transmitting the final report of the board to Congress, January 14, 1880. A reprint of this message is on display in the Mechanical Section of the Watertown Arsenal Laboratory.

As a part of the acceptance test in 1879, a forged link of wrought iron 5 inches in diameter was broken at 722,800 pounds. Immediately following this test a horsehair 0.007-inch in diameter was slowly strained and stretched 30 per cent before breaking under a load of one pound indicated by the scale. As a check, subsequent tests on bits of the horsehair were also broken by dead weights of one pound.

Emery's machine is the same today as in 1879. Two of its original outstanding and unique design features are still features of Baldwin testing machines built today. These are the hydraulic load cells and the use of flexure bars or plates where very small movements are necessary.

Hydraulic Load Cell

The hydraulic load cell is basically a shallow cylinder having a loose-fitting piston and a metal diaphragm so arranged that the load on a test specimen must pass through a thin film of liquid trapped between the diaphragm (backed by the piston) and the bottom of the cylinder. Piston movement is, of course, almost negligible.

A bridge ring which supports the diaphragm over the clearance space between piston and cylinder, and centers the piston so that it does not touch the cylinder wall, is the only significant

change in Emery cell design since 1879. This change has lengthened the life of the diaphragm.

The original Emery cells on the testing machine were connected with a smaller Emery cell in the load-weighing cabinet, thus providing a hydraulic lever giving the first load reduction to the mechanical lever system. The use of flexures instead of knife-edge pivots is an outstanding design feature of the lever system.

New Application

Flexures were used on both the testing machine and the weighing-lever system. Although this idea was not unknown at the time, careful search has failed to reveal that the idea had ever been applied before 1879. The illustration on page 701 shows the flexure bars which serve to preload the Emery load cells and allow for the almost negligible compression of the cells under load.

The two 8½-inch-diameter screws through which the testing load is applied are 48 feet long and threaded for a length of 38 feet with a truncated thread, 2 per inch. Since there were no lathes large enough to take a bar of steel of this length in 1879, it is reported that the bars were mounted for turning in such a way that a standard 4-foot lathe could be moved along in steps, turning short lengths of thread in each position until the full-length thread was produced.

The finished screws are true in diameter within 0.001-inch. Their centerlines and that of the testing machine are in a horizontal plane forty-seven inches above floor level.

The loading cylinder and one set of specimen grips travel on rail carriages driven by a keyed gear that slides on a horizontal shaft near floor level. Gear trains turn four nuts on the two horizontal screws, thus positioning the grips and loading cylinder to suit the length of the test specimen.

Double-Acting Piston

A double-acting piston in the loading cylinder has a 20-inch diameter head and 10-inch diameter piston rod forged in one piece, thus providing 800,000 pounds in tension and a little more than 1,000,000 pounds' in compression with oil at 3,400 pounds pressure. It has a 24-inch stroke applied up to one inch per minute. Hydraulic pressure is delivered to the loading cylinder through piping supported like a pantograph above the machine to allow movement of the loading cylinder. Hydraulic fluid, originally sperm oil, flows through four 1/16-inch-diameter ducts in pipe that has an outside diameter of one inch. Three pipes are connected on the carriage and the fourth to the stationary grips. Grips may be applied hydraulically with a force of 1,000,000 pounds if required. Gripping pressure is indicated on the left-hand dial of the new indicator cabinet by means of a precision-type Bourdon gage.

It is natural that today the Watertown Arsenal Laboratory is still working to improve the metals that go into armament—guns, shells, armor plate, etc. Much use is being made of the old testing machine to determine the strains in the barrels of big guns and in the shells that pass through them.

Strain Gages Used

In a recent test, 28 SR-4 resistance-wire strain gages were bonded transversely on the outside surface of a 240-mm. gun barrel and other gages were bonded to the 240-mm. shell to be pushed through the rifled bore. As the shell was pushed through the barrel, strains were measured by Baldwin Type K strain-gage indicators using switching units for making connections.

It is interesting to note in connection with the wide use of resistance-wire strain gages that before rejuvenation of the old testing machine, SR-4 gages were bonded to the hydraulic ram of the machine and calibrated so that loads could be measured in this way. Although this method of load measurement is practical, it requires more refinement for the accuracies demanded at the Watertown Arsenal.

In general, the components of the testing machine were built more massively than would have been necessary today. This mass makes up for the low physical properties of the materials then available. Yield strength of the castings is believed to be between 30,000 and 40,000 pounds per square inch.

Use of the testing machine has never been limited to Government projects alone but has been available to American industry also. In a recent Battelle Memorial Institute project, load measurements were made on short steel cylinders after being cold-worked in varying amounts up to twenty-five per cent.

Harold C. Mann

Harold C. Mann, who was in charge of the Mechanical Testing Section at Watertown Arsenal from 1919 to 1940, was responsible for a great portion of the research work accomplished in impact testing. During this period he designed and built a variable-velocity impact testing machine. With this machine it was possible to conduct impact tests on metals at speeds up to 350 feet a second, as compared with 30 feet a second which had been the highest testing speed obtainable until Mr. Mann's machine was invented.

For this work he was honored on July 1, 1936, by being presented the Charles B. Dudley Gold Medal for Meritorious Research in Materials by the American Society for Testing Materials.

Patent rights for the Emery machine were sold to Yale & Towne, Stamford, Conn., in 1833, and 8 machines were built in capacities ranging from 70,000 to 300,000 pounds. Cambria Iron Company, Johnstown, Pa., and Bethlehem Iron Company, Bethlehem, Pa., each acquired one of the largest.

Patent Rights Bought

William Sellers & Company then bought patent rights and built several more of the machines between 1889 and 1905. A few years later Congress approved construction of a horizontal Emery universal machine of 2,300,000 pounds' capacity in compression and half that in tension for the National Bureau of Standards.

For the past twenty years the Baldwin Locomotive Works, and more recently the Baldwin-Lima-Hamilton Corporation, has continued to build hydraulic testing machines, both vertical and horizontal, to meet every requirement. The A. H. Emery Company, founded by the original A. H. Emery, continues to furnish modern, sensitive, and accurate weighing systems incorporating many of the basic principles of the Watertown Arsenal machine. More than 2,000 of these machines are now in use throughout the world.

"Roll with the Punch"

The Task of Transportation Agencies in Civil Defense

William S. Lawrence

A UNITED STATES Strategic Bombing Survey team concluded in a postwar analysis that "the attack on transportation beginning September 1944 was the most important single cause of Germany's ultimate economic collapse."

An Opposite View

On the other hand, the Department of State's Director of Research of the U.S.S.R. and Eastern Europe stated in April 1952: "I personally worry a great deal about the faith we put in our ability to destroy the enemy's transportation in light of what has happened in Korea. There we have had absolute supremacy of the air, and on paper we should have had those forces without any sort of support long since. Actually, they keep getting supplies."

There is no conflict in these statements. They team to attest the fact that transportation is indispensable to military effort, including home industrial support of the armed forces, and that with careful planning transportation can keep functioning despite concentrated demolition and incendiary-bomb attacks. These twin facts are of the utmost importance.

Home Front Vulnerable

In military offense, transportation's vehicles of war, such as the intercontinental bomber and snorkel submarine, are adapted to a modern warfare that contemplates jumping boundary defenses and destroying the enemy's industries, institutions, and civilian workers on the home front. Atomic weapons and biological- and chemical-warfare devices, abetted by the guided missile, make this feasible.

The defensive answer to this type of attack is civil defense. Organized civil defense has consequently become so important that it is rated by the Department of Defense as an equal partner with the military on the national-defense team.

An adequate and effective civil defense utilizes existing facilities and depends greatly upon national flexibility born of quick and orderly emergency movement. The transportation industry, an existing emergency-tested facility, is the key to quick and orderly emergency movement. Hence the transportation industry is a key to an effective and adequate civil-defense program.

Adequate transportation facilities to meet emergency civil-defense needs are for the most part already in existence. However equipment, services, and personnel are so widely distributed and in such constant daily use that the problem of transportation in civil defense lies mainly in proper advance preparation.

Disaster Duties

In the event of a war-caused disaster, organized emergency transportation will be needed for movement of the following: special civil-defense teams and equipment; rescue personnel and equipment; police, medical, and health teams; emergency labor parties; engineering and utility crews; persons or property under mutual-aid arrangements; and food and emergency supplies, including water. In addition, transportation will be needed for messenger service; transport of rescued persons, seriously injured and hospital patients and evacuees; for emergency mobile transport reserve; and for such other services as may be necessary.

Mr. Lawrence is director of the Transportation Services Division of the Federal Civil Defense Administration, Washington, D.C.

It cannot be assumed that adequate transportation services will be readily available for these purposes. Transportation equipment will doubtless be in short supply due to the impact of the wartime load. Shortages may be aggravated and efficiency impaired by destruction and damage from enemy action.

No War Disasters

The transportation industry in the United States has exhibited more than once its ability to function in spite of emergencies and disasters. However we have never been subjected to a disaster and the consequent emergency such as could be visited upon us in the event an enemy launched an all-out simultaneous atomic attack on our critical home-front areas.

The Transportation Services Division of the Federal Civil Defense Administration has the benefit of advice and guidance of specialists and experts from all facets of the field in its planning. In addition to a general Transportation Advisory Committee, there are advisory committees on transportation by air, highway, rail, and water. There are related emergency advisory committees on: clearance and repair of streets, highways, and airfields under disaster conditions; clearance of harbors and inland waterways; repair and operation of water facilities in disasters; repair and restoration of terminal and pier facilities; repair of railroad facilities in disasters; and street and highway traffic regulation control.

Committee Membership

Membership on these active committees is drawn from the public carriers, equipment manufacturers, the military, the Government, transportation associations, and representatives from management and labor.

FCDA, through its Transportation Services Division, sponsored in April a national conference on emergency defense transportation. It was well attended by transportation experts representing all the major rail, air, water, and highway transportation companies; Government, military, and port authorities; transportation associations and clubs; and organized labor. Resolutions were drawn up and constructive plans laid to coördinate all U. S. transportation for instant and synchronized emergency civil-defense action.

Broad Powers Granted

In the problem area, FCDA made its policy clear in regard to the broad emergency powers granted it under the Federal Civil Defense Act which allow the agency to "acquire necessary facilities, by condemnation or otherwise, without regard to any existing law," in case a state of civil-defense emergency is declared by Congress or the President.

Transportation facilities will be operated by their owners, and civil-defense transportation for Federal, State, and local levels will be provided by operational groups recruited in so far as possible from the personnel of the transportation industry.

Actual application of civil-defense operations is a State and local matter. Transportation chiefs in the State civil-defense organizations have carefully worked out plans for the central control of supporting forces from non-target to target areas. Interstate agreements include arrangements for movement of local transportation over State lines. Local transportation chiefs are tackling the problems of main and alternate routes to and from target-zero areas and of wise dispersal of equipment and personnel.

Every type of transportation has its place in the civil-defense transportation program:

Rail and Air Transport

Rail.—The Association of American Railroads, whose members control 1,796,954 cars, is in continuous contact with the FCDA for the utilization of their rolling stock in time of emergency.

Air.—Commercial airlines indicate that 1,200 aircraft could be assigned to civil-defense transportation in case of need. Approximately 75 per cent of the 60,000 planes not engaged as air carriers over regular routes are available for civil-defense activities if required. The Air Transportation Advisory Panel has prepared a guide, "Aviation in Civil Defense," for the use of plane owners and pilots.

71,000 Water Craft

Water.—The Coast Guard civil auxiliaries are being organized for civil defense, with a potential resource of over 71,000 water craft, 350 planes, 216 radio stations, and over 13,000 individuals. Agreements have been reached with the Maritime Commission for emergency use of seagoing vessels of all tonnages. The Association of Inland Waterways and the Lake Carriers Association have agreed also to the use of shipping under their jurisdiction. In cities like San Francisco and New York, which can be cut off from most other types of transportation contact, water craft are organized into plans for any necessary evacuation.

In all, vessels now available for civil-defense transportation total 35,914 and are manned or directed by 246,000 employees.

5,500,000 Trucks

Highway.—The American Trucking Association, whose members operate almost 5,500,000 heavy trucks and have 11,000,000 employees, have pledged full civil-defense coöperation. An inventory has been made of 2,400 trucks equipped with 2-way radio which can be pressed immediately into civil-defense work in time of need.

Almost 68,000 light trucks owned and operated by laundries, linen services, etc., will be used as emergency ambulances through the coöperation of the textile maintenance industries. Some of these trucks have already been adapted with emergency fittings for test exercises. Many other types of light trucks from private industry and associations are being enrolled and adapted in major cities.

Approximately 90,000 intercity and transit buses, with 210,000 employees, have been mobilized through the National Association of Motor Bus Operators and the American Transit Association.

Plans are being made with the Defense Transportation Administration to use the Nation's 110,000 school buses for civil-defense work if necessary.

Of the 150,000 taxicabs now in use, about 70,000 have 2-way radio. The American Taxicab Association already has pledged its support to FCDA, and conferences are being held with the National Association of Taxicab Owners.

Personnel Training

One of the concerns of FCDA is to train personnel to use existing facilities under emergency disaster conditions. Some communities are making considerable progress in training auxiliary corps of women to take over operation of emergency transportation facilities. The Traffic Institute of Northwestern University has announced five special courses to teach civil-defense teams how to keep roads open in case of air attack.

FCDA has announced the first of a series of special courses on emergency traffic control at its staff college at Olney, Md.; to be followed by similar courses at Northwestern University; the FCDA Central Training School, Stillwater, Okla.; and the FCDA Western Training School, St. Mary's College, Moraga, Calif.

An atomic bomb, combining as it does blast and fire destructiveness, would undoubtedly cause unprecedented damage and confusion to any one of our critical target areas. Civil defense is planned to meet just such an unprecedented situation and minimize loss of life and property. Transportation, a key to effective civil defense, is readying for unprecedented action under unprecedented conditions.

Transportation Is Ready

The underlying principle of civil defense is to roll with the punch. Should the need ever arise, transportation will be ready to roll—on the ground, on the rails, on the water, under the water, and in the air.

EDITOR'S NOTE.—This is the second of a series of two articles prepared for ORDNANCE by the Federal Civil Defense Administration. The first article, "Civil Defense Means Self-Defense," by Gerald R. Gallagher, Assistant Administrator for Technical Operations, FCDA, appeared in the July-August 1952 issue of ORDNANCE, page 95.

TIMKEN® bearings keep high speed boring mill accurate and free from vibration

THIS 52" King boring mill is especially designed for boring diesel locomotive wheels and facing the rims and hubs. Because carbide tooling is required, the table must rotate at high speeds. To insure smooth boring and facing, the King Machine Tool Division of American Steel Foundries mounts the table spindle on Timken® precision tapered roller bearings. They keep the table accurate, eliminate vibration.

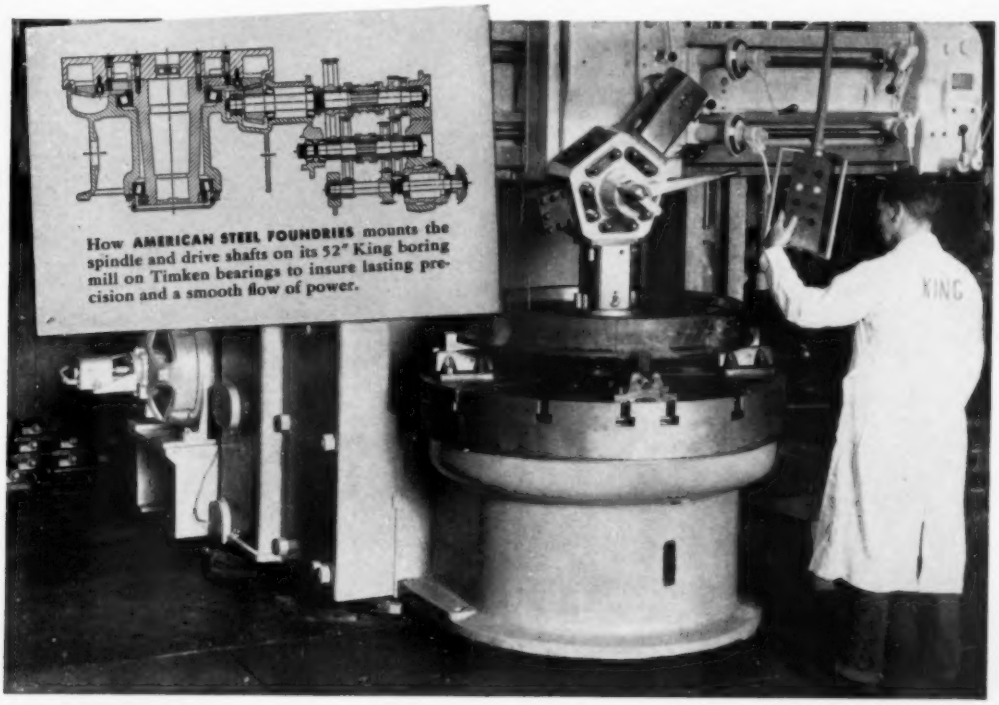
Timken precision bearings are specifically designed for spindle applications. They have capacity for any tool loads because line contact between rollers and races provides load-carrying capacity to spare.

Because of tapered construction, Timken bearings take both radial and thrust loads. Spindles are held in rigid alignment and can be pre-loaded to any desired degree.

The King Machine Tool Division uses Timken bearings on the main drive shaft and in the constant speed and variable speed drives to hold shafts in accurate alignment and insure proper gear meshing.

No other bearing can give you all the advantages you get with Timken bearings. Make sure you have them in the machine tools you buy or build. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **AMERICAN STEEL FOUNDRIES** mounts the spindle and drive shafts on its 52" King boring mill on Timken bearings to insure lasting precision and a smooth flow of power.

WE MAKE OUR OWN STEEL

The special grade alloy steel which gives Timken bearings their strength and resistance to wear is made in our own steel mills.

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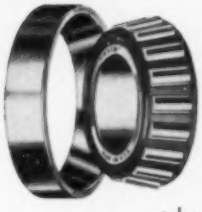
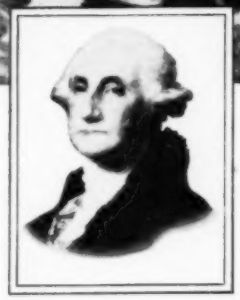


NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION →◫←

Hunting—another great American heritage



Barking hounds . . . blaring horns . . . tallyho! Many a clear Virginia morning watched George Washington as he went "riding to hounds." The "Father of Our Country" was another famous American who loved every form of hunting. His diaries, preserved in the State Dept. at Washington, D. C., are full of references to the sport.

"Rid out with my gun"; "went ducking"; "went a-gunning up the Creek" are among entries describing trips in search of game. And the diaries display the great man's reputation for truthtelling as well. Frank to admit failure, he reported: "Found both a bear and a fox, but got ne.ther"; "went hunting . . . startled a deer and then a fox, but got neither." All the thrills and disappointments of hunting were keenly felt by George Washington, hunter.

For satisfaction and solid enjoyment, hunting can't be matched by any other sport. It has long built character, self-reliance and endurance . . . provided many thrilling hours for millions of marksmen.

You can help promote the popular sport of hunting by taking an active part in local and national conservation programs. Remember—conservation today means good shooting tomorrow! E. I. du Pont de Nemours & Co. (Inc.), Explosives Department, Wilmington 98, Delaware.

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VOLUME XXXVII, NO. 196 SECTION II JANUARY-FEBRUARY 1953

LAND SEA AIR ORDNANCE

THE ANNUAL DIRECTORY SECTION 1953

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AMERICAN ORDNANCE ASSOCIATION

Founded 1919

A patriotic, educational, scientific, nonpolitical, and nonprofit-making organization of American citizens dedicated to scientific and industrial preparedness for the common defense

ORDNANCE is the generic term embracing:

All weapons and appurtenances for their operation and maintenance.

All ammunition and its chemical, metallurgical, and atomic components.

All rockets, bombs, guided missiles, torpedoes, depth charges, and mines.

All combat vehicles, tanks, tank destroyers, and weapon carriers.

All vehicles for automotive transport of personnel and matériel on land.

All optical, aërial, mechanical, electrical, and electronic systems for locating and tracking targets on land, at sea, and in the air.

- The need for a civilian association of private citizens to coöperate with the ordnance organizations of our Armed Forces arises from the fact that, in the United States, in accordance with traditional national policy, there is little or no private industry for the production of ordnance in time of peace. Yet in time of emergency, as our experience in two world wars so tragically proved, ordnance of superior quality and in great quantities must be available in a very minimum of time for the use of our armed forces in order to avoid incurring unnecessary expenditures of hundreds of millions of dollars and, infinitely more important, the sacrifice of hundreds of thousands of American lives.

- Trained scientists and engineers in the laboratories and industrial establishments of our country, alert executives and key men of our factories and plants, students at our technical colleges, and artisans of our vast economy—all are united through membership in the American Ordnance Association in the firm determination to achieve peace through strength by providing superior ordnance for our Armed Forces.

- To keep alive a knowledge of ordnance design and production; to assist in the solution of the ramified technical, scientific, and economic problems incident to ordnance preparedness; to weld into an active, alert, and skilled group all eligible citizens for the advancement of scientific and industrial preparedness, and thus to contribute to the strength of our national security and the maintenance of peace—these are the goals of the American Ordnance Association, and to these ends its constitution and by-laws are directed. An organization chart of the Association is on pages 20 and 21.

American Ordnance Association

COUNCIL

The elective body of the Association is its Council composed of one member representing each local Post, one member representing each Technical Division, the three immediate past presidents, the charter national officers and directors, and twenty-four members at large.

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(Student Posts are not represented on Council)

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Levin H. Campbell, Jr.—until December 31, 1956—Automotive Safety Council, Washington, D. C.

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Local Posts of the A.O.A.

Posts of the Association are formed for the general purpose of cultivating a more intimate understanding of ordnance subjects through meetings, plant visits, seminars, and reports on particular ordnance problems.

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G. A. Gustafson, Ordnance Corps, Aberdeen Proving Ground, Md.
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W. R. Slaughter, Ordnance Corps, Aberdeen Proving Ground, Md.
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S. H. Woods, Ordnance Corps, Aberdeen Proving Ground, Md.

Birmingham Post, December 3, 1930

President: Bradford C. Colcord, Woodward Iron Company, Birmingham, Ala.
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C. Pratt Rather, Southern Natural Gas Company, Birmingham, Ala.
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Walker Reynolds, Alabama Pipe Company, Anniston, Ala.
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Capital Cities Post, February 8, 1950

President: Ernest E. Johnson, General Electric Company, Schenectady, N. Y.
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Wendell Westover, Westover-Wolfe Contracting Company, Albany, N. Y.

Central Illinois Post, May 29, 1945

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Harvey C. Knowles, Procter & Gamble Company, Cincinnati, Ohio.
Harold R. LeBlond, Cleveland Automatic Machine Company, Norwood, Ohio.
E. A. Muller, 2936 Observatory Avenue, Cincinnati, Ohio.
Louis Polk, Sheffield Corporation, Dayton, Ohio.
Peter E. Rentschler, Hamilton Foundry & Machine Company, Hamilton, Ohio.

The Citadel Post, February 21, 1951

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Cleveland Post, October 25, 1940

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Vice-Presidents: J. E. Trainer, Firestone Tire & Rubber Company, Akron, Ohio.
William Forster, Hays Manufacturing Company, Erie, Pa.
Secretary-Treasurer: J. C. McHannan, Central National Bank of Cleveland, Cleveland, Ohio.
Directors: The officers and Robert F. Black, White Motor Company, Cleveland, Ohio.
George C. Brainard, Addressograph-Multigraph Company, Euclid, Ohio.
Ward M. Canaday, Willys-Overland Motors, Inc., Toledo, Ohio.
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Frederick C. Crawford, Thompson Products, Inc., Euclid, Ohio.
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Harvey B. Jordan, American Steel & Wire Company, Cleveland, Ohio.
Adrian D. Joyce, Glidden Company, Cleveland, Ohio.
Albert Miller, Central Ohio Paper Company, Columbus, Ohio.
William Ong, American Steel & Wire Company, Cleveland, Ohio.
Frank Purnell, Youngstown Sheet & Tube Company, Youngstown, Ohio.
Henry A. Roemer, Jr., Sharon Steel Corporation, Sharon, Pa.
W. Robert Timken, Timken Roller Bearing Company, Canton, Ohio.
C. M. White, Republic Steel Corporation, Cleveland, Ohio.
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Columbia River Post, June 14, 1950

President: Byron J. Beattie, Beattie & Company, Portland, Oreg.
First Vice-President: W. L. McCarter, Screw Machine Products Company, Portland, Oreg.
Second Vice-President: A. F. McGarr, Lomac Motors, Portland, Oreg.
Secretary: J. A. Gay, Lomac Motors, Portland, Oreg.
Treasurer: Gordon G. Tupling, Bearing Engineering Company, Portland, Oreg.
Directors: The officers and Edward Haas, Ballou & Wright, Portland, Oreg.
Haskell C. Carter, Carter Manufacturing Company, Portland, Oreg.
Theodore Emerson, Bonneville Power Administration, Portland, Oreg.
W. A. Gish, Pacific Power & Light Company, Portland, Oreg.
Ashley Green, attorney, Portland, Oreg.
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El Paso (Rio Grande) Post, November 6, 1952

President (pro tem.): Henry E. Minton, El Paso, Tex.
Secretary (pro tem.): C. A. Lindeman, Darbyshire Steel Company, El Paso, Tex.
(Other officers and directors to be elected.)

Empire Post, April 29, 1938

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First Vice-President: Keith Williams, Pratt & Letchworth Company, Buffalo, N. Y.
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James E. Gleason, Gleason Works, Rochester, N. Y.
Francis R. Gorman, Gorman & Halpern, Utica, N. Y.
Edward A. Halbleib, Victor Insulator Company, Rochester, N. Y.
Carl S. Hallauer, Bausch & Lomb Optical Company, Rochester, N. Y.
Myron J. Hayes, Eastman Kodak Company, Rochester, N. Y.
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Thomas L. Lee, Rochester, N. Y.
Reginald Lenna, Blackstone Corporation, Jamestown, N. Y.
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H. B. Sheets, Marine Trust Company, Buffalo, N. Y.
Keith Williams, Pratt & Letchworth Company, Buffalo, N. Y.

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Membership Committee: Ray C. Neal, R. C. Neal Company, Buffalo, N. Y.
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Treasurer: Walter Schmidt, Niagara Mohawk Power & Light Company, Niagara Falls, N. Y.

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Chairman: C. Earl Norquist, Norquist Products, Inc., Jamestown, N. Y.

Mohawk Valley Chapter, Empire Post

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Rochester Chapter, Empire Post

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Secretary: F. N. Tracy, Ward LaFrance Truck Corporation, Elmira, N. Y.

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Secretary: Gwyn Thomas, Manufacturers Association of Syracuse, Chamber of Commerce Building, Syracuse, N. Y.

Tri-Cities Chapter, Empire Post

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Florida Post, June 12, 1951

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H. L. Hawkins, Eglin Air Force Base, Fla.
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M. G. Hugo, Eglin Air Force Base, Fla.
J. R. Langley, Eglin Air Force Base, Fla.
R. M. Sinnen, Eglin Air Force Base, Fla.
P. Steiner, Eglin Air Force Base, Fla.
E. C. Williamson, Jacksonville, Fla.

Hartford-Springfield Post, November 18, 1941

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Directors: F. H. Payne, Springfield, Mass., *chairman;* the officers and
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E. P. Bullard, Bullard Company, Bridgeport, Conn.
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C. B. Dick, Westinghouse Electric Corporation, Springfield, Mass.
G. H. Drewry, Niles-Bement-Pond Company, West Hartford, Conn.
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D. P. Hess, American Bosch Corporation, Springfield, Mass.
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L. E. Lentz, Underwood Corporation, Hartford, Conn.
D. G. Millar, Greenfield Tap & Die Corporation, Greenfield, Mass.
C. B. Parsons, American Hardware Corporation, New Britain, Conn.
H. H. Pease, New Britain Machine Company, New Britain, Conn.
R. E. Pritchard, Stanley Works, New Britain, Conn.
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James Y. Scott, Van Norman Company, Springfield, Mass.
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Lone Star Post, June 12, 1945

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Directors: G. H. Brown, Wichita Engineering Company, Wichita Falls, Tex.
S. P. Hamer, Liberty Manufacturing Company, Fort Worth, Tex.
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Donald Mitchell, John E. Mitchell Company, Dallas, Tex.
M. J. Neeley, Hobbs Manufacturing Company, Fort Worth, Tex.
R. H. Norris, Dearborn Stove Company, Dallas, Tex.

Los Angeles Post, May 27, 1936

President: W. A. Wilson, Web Wilson Oil Tools, Inc., Los Angeles, Calif.
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Secretary: C. H. Nazro, Byron Jackson Company, P. O. Box 2017 Terminal Annex, Los Angeles 54, Calif.
Treasurer: Samuel K. Rindge, Citizens National Trust & Savings Bank, Los Angeles, Calif.

Directors: The officers and Henry L. Clark, General Motors Corporation, South Gate, Calif.
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P. W. Lizza, Bermite Powder Company, Saugus, Calif.
Walter C. Main, Oakland, Calif.
J. P. McCafferty, Los Angeles, Calif.
K. T. Norris, Norris-Thermador Corporation, Los Angeles, Calif.
Morris B. Pendleton, Plomb Tool Company, Los Angeles, Calif.
John B. Rauen, U. S. Spring & Bumper Company, Los Angeles, Calif.
J. D. Spalding, National Supply Company, Torrance, Calif.
C. B. Tibbetts, Los Angeles Steel Casting Company, Huntington Park, Calif.

Louisiana Post, May 24, 1950

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Directors: Russell A. Cuyler, Louisiana Power & Light Company, New Orleans, La.
J. Mason Guillory, New Orleans Public Service, Inc., New Orleans, La.
Ernest A. Merklein, Merklein and Company, Shreveport, La.
J. Edgar Monroe, Boland Machine & Manufacturing Company, New Orleans, La.
W. C. Nabors, W. C. Nabors Company, Mansfield, La.

Massachusetts Institute of Technology Post, January 20, 1922

President: Stanley A. Hoff, Cambridge, Mass.
Vice-President: Ernest P. Abrahamson, II, Cambridge, Mass.
Secretary-Treasurer: Robert H. Tucker, 100 Memorial Drive, Cambridge 39, Mass.
Faculty Adviser: Lieut. Col. Samuel D. Hall, R.O.T.C. Ordnance Detachment, Massachusetts Institute of Technology, Cambridge, Mass.

Michigan Post, December 12, 1942

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Directors: Robert L. Biggers, Fargo Division, Chrysler Corporation, Detroit, Mich.
Henry T. Bodman, National Bank of Detroit, Detroit, Mich.
Harold R. Boyer, General Motors Corporation, Detroit, Mich.
Walter O. Briggs, Jr., Briggs Manufacturing Company, Detroit, Mich.
Kenneth B. Coates, Great Lakes Steel Corporation, Detroit, Mich.
John S. Coleman, Burroughs Adding Machine Company, Detroit, Mich.
Irving A. Duffy, Ford Motor Company, Detroit, Mich.
John F. Gordon, General Motors Corporation, Detroit, Mich.
Edward T. Gushée, Detroit Edison Company, Detroit, Mich.
Charles L. Jacobson, Chrysler Motor Parts Corporation, Detroit, Mich.
Charles S. Mott, Mott Foundation, Flint, Mich.
John W. Paynter, J. L. Hudson Company, Detroit, Mich.
C. J. Reese, Continental Aviation & Engineering Corporation, Muskegon, Mich.
George H. Roderick, American Seating Company, Grand Rapids, Mich.
A. M. Wibel, Nash-Kelvinator Corporation, Detroit, Mich.

Lansing Chapter, Michigan Post

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Vice-Presidents: Glen Whisler, Reo Motors, Inc., Lansing, Mich.
Secretary: Eldon Robbins, John Bean Division, Food Machinery & Chemical Corporation, Lansing 4, Mich.
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Frederik Marin, Bank of Lansing, Lansing, Mich.
Clarence A. Trump, Fisher Body Division, GMC, Lansing, Mich.

Western Michigan Chapter, Michigan Post

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Directors: Britton L. Gordon, Blackmer Pump Company, Grand Rapids, Mich.
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S. K. Harrington, A-B Stoves, Battle Creek, Mich.
George Roderick, American Seating Company, Grand Rapids, Mich.
Frederick Vogt, Knape and Vogt Manufacturing Company, Grand Rapids, Mich.
Roger Waindle, Nugent Sand Company, Muskegon, Mich.

Mid-Continent Post, December 12, 1944

President: M. H. Johnson, Independent Plow, Inc., Neodesha, Kans.
Vice-President: R. R. King, American Body & Trailer Company, Oklahoma City, Okla.
Consulting Engineer: W. H. Steuve, Oklahoma City, Okla.
Secretary-Treasurer: C. B. Horton, Horton Engineering Company, A211 E. Seventh Street, Tulsa, Okla.
Directors: Frank Hinderliter, Tulsa, Okla.
George Nicholson, Tulsa, Okla.
Walter O'Bannon, Jr., Tulsa, Okla.
Ed Warmack, Warmack Stove Company, Fort Smith, Ark.

Midwest Post, May 16, 1945

President: Harry Darby, Darby Corporation, Kansas City, Kans.
First Vice-President: J. C. Shepherd, Sheffield Steel Corporation, Kansas City, Mo.
Second Vice-President: C. M. Standiford, Crawford Manufacturing Company, Kansas City, Kans.
Secretary-Treasurer: Fred B. Nichols, Mid-Continent Paint Manufacturing Company, 1921 Central Street, Kansas City 8, Mo.
Directors: Leroy M. Alexander, Sheffield Steel Corporation, Kansas City, Mo.
Paul Froeschl, Wilde Drop Forge & Tool Company, Kansas City, Mo.
Elmer Pierson, Vendo Company, Kansas City, Mo.
Philip Rahm, Darby Corporation, Kansas City, Kans.
Kenneth Spencer, Spencer Chemical Company, Kansas City, Mo.
E. J. Ziegler, Keystone Trailer & Equipment Company, Kansas City, Mo.

Milwaukee Post, September 26, 1928

President: Frederick D. Hansen, Evans-Hansen, Milwaukee, Wis.

Vice-President: N. Rulison Knox, Bucyrus-Erie Company, South Milwaukee, Wis.
Secretary-Treasurer: Jacobus Kruyne, Home Savings Bank, 2200 North Third Street, Milwaukee, Wis.
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Leon R. Clausen, J. I. Case Company, Racine, Wis.
W. W. Coleman, Bucyrus-Erie Company, South Milwaukee, Wis.
J. E. De Long, Waukesha Motors Corporation, Waukesha, Wis.
Harold S. Falk, Falk Corporation, Milwaukee, Wis.
George H. Fobian, Oilgear Company, Milwaukee, Wis.
Frederick D. Hansen, Evans-Hansen, Milwaukee, Wis.
W. C. Heath, A. O. Smith Corporation, Milwaukee, Wis.
H. Stanley Johnson, Jr., Gisholt Machine Company, Madison, Wis.
N. Rulison Knox, Bucyrus-Erie Company, South Milwaukee, Wis.
Herbert V. Kohler, Kohler Company, Kohler, Wis.
J. Clifford Merwin, Chain Belt Company, Milwaukee, Wis.
William A. Roberts, Allis-Chalmers Manufacturing Company, West Allis, Wis.
Robert A. Uihlein, Jos. Schlitz Brewing Company, Milwaukee, Wis.
Pierpont J. E. Wood, Jeffres, Mouat, Oestreich, Wood & Cunningham, Janesville, Wis.

Nebraska Post, June 22, 1944

President: Ben Hughes, Hughes Brothers Company, Seward, Nebr.
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F. H. Bucholz, Omaha Steel Works, Omaha, Nebr.
Clyde Dempster, Dempster Mill Manufacturing Company, Beatrice, Nebr.
Karl Vogel, State Senator, Omaha, Nebr.

New York Post, June 15, 1921

President: George F. Hussey, Jr., American Standards Association, New York, N. Y.
Vice-Presidents: J. L. Auer, R. Hoe & Company, New York, N. Y.
H. T. Luria, Luria Steel & Trading Corporation, New York, N. Y.
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A. E. Van Cleve, Crucible Steel Company of America, New York, N. Y.

Northwest Post, March 15, 1945

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Charles L. Horn, Federal Cartridge Corporation, Minneapolis, Minn.
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Harry A. Bullis, General Mills, Inc., Minneapolis, Minn.
Richard P. Carlton, Minnesota Mining & Manufacturing Company, St. Paul, Minn.
Walter F. Kasper, Fairmont Railway Motors, Inc., Fairmont, Minn.
Warren C. MacFarlane, Jr., Minneapolis-Moline Company, Minneapolis, Minn.
Luther S. Oakes, Winston Brothers Company, Minneapolis, Minn.
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Donald A. Smith, Smith, Inc., Fargo, N. Dak.
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Harold O. Washburn, American Hoist & Derrick Company, St. Paul, Minn.
Alfred M. Wilson, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.
Frank B. Winston, Winston Brothers Company, Minneapolis, Minn.
Brison Wood, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.

Philadelphia Post, December 9, 1926

President: Albert W. Gilmer, Barnes, Dechert, Price, Myers & Rhoads, Philadelphia, Pa.
Vice-Presidents: Edward G. Budd, Budd Company, Philadelphia, Pa.
Howard S. Lewis, Parish Pressed Steel Company, Reading, Pa.
Walter C. Pew, Philadelphia, Pa.
William S. Worrilow, Lebanon Steel Foundry, Lebanon, Pa.
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Directors: Henry W. Gadsden, Sharp & Dohme, Philadelphia, Pa.
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Ernest J. Langham, Sun Oil Company, Philadelphia, Pa.
Stewart E. Lauer, York Corporation, York, Pa.
George P. Luckey, Hamilton Watch Company, Lancaster, Pa.
Henry N. Marsh, Hercules Powder Company, Wilmington, Del.
William J. Meinel, Heintz Manufacturing Company, Philadelphia, Pa.
Howard C. Peterson, Fidelity-Philadelphia Trust Company, Philadelphia, Pa.

Walter C. Pew, Philadelphia, Pa.
Marshall Post, Birdsboro Steel Foundry & Machine Company, Birdsboro, Pa.
Charles S. Redding, Leeds & Northrup Company, Philadelphia, Pa.
Martin Sandler, Daytona Beach, Fla.
J. T. Simpson, Harrisburg Steel Corporation, Harrisburg, Pa.
Arthur J. Seiler, Main Belting Company, Philadelphia, Pa.
George W. Struble, Bethlehem Steel Company, Bethlehem, Pa.
Marvin W. Smith, Baldwin-Lima-Hamilton Corporation, Eddystone, Pa.
Everett B. Webster, Crown Can Company, Philadelphia, Pa.
Henry H. Ziesing, Midvale Company, Philadelphia, Pa.

Pittsburgh Post, February 24, 1927

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Brehon B. Somervell, Koppers Company, Pittsburgh, Pa.
S. A. Swensrud, Gulf Oil Corporation, Pittsburgh, Pa.
A. E. Walker, National Supply Company, Pittsburgh, Pa.
I. W. Wilson, Aluminum Company of America, Pittsburgh, Pa.

Puget Sound Post, January 25, 1944

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Secretary-Treasurer: Fairman B. Lee, Fairman B. Lee Company, Seattle, Wash.
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Robert Nelson, Standard Service Tire Company, Seattle, Wash.
A. F. Parker, Northwest Metal Company, Seattle, Wash.
Ferdinand Schmitz, Berger Engineering Company, Seattle, Wash.
Alex Thomson, Pacific Car and Foundry Company, Renton, Wash.
Walter Toly, Columbia Electric Company, Spokane, Wash.
Ray O. Welch, Mt. Rainier Ordnance Depot, Tacoma, Wash.

Quad Cities-Iowa Post, May 28, 1945

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Vice-President: P. S. Mumford, American Machine & Metals, Inc., East Moline, Ill.
Secretary-Treasurer: Donald L. Meyers, Rock Island Arsenal, Rock Island, Ill.
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C. E. Murray, Englehart Manufacturing Company, Davenport, Iowa.
E. W. Ross, Minneapolis-Moline Company, Moline, Ill.
M. M. Schmidt, Deere Manufacturing Company, Des Moines, Iowa.
T. E. Stahl, J. I. Case Company, Bettendorf, Iowa.
G. A. Uhlmeyer, Iowa-Illinois Gas & Electric Company, Rock Island, Ill.
C. A. Waldmann, Deere & Company, Moline, Ill.
W. W. Warner, Rock Island Arsenal, Rock Island, Ill.
C. D. Wiman, Deere & Company, Moline, Ill.

Rocky Mountain Post, June 10, 1942

President: James D. Maitland, Cobusco Steel Products, Denver, Colo.
Vice-President: **James Colasanti, Metal Treating & Research Company, Denver, Colo.**
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Stanley C. Shubart, Schloss & Shubart, Denver, Colo.
Harold F. Silver, Silver Engineer Works, Denver, Colo.
T. C. Timpte, Timpte Brothers, Denver, Colo.
J. R. Travis, Eaton Metal Products Company, Denver, Colo.
C. W. Webb, Armco Drainage & Metal Products Company, Denver, Colo.
Adolph D. Weiss, Winter-Weiss Company, Denver, Colo.

St. Louis Post, January 18, 1927

President: Granville A. Waters, Wagner Electric Corporation, St. Louis, Mo.
Vice-President: Charles P. Whitehead, General Steel Castings Company, Granite City, Ill.
Secretary: William P. Gatley, National Rejectors, Inc., St. Louis, Mo.
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Directors: W. M. Akin, Laclede Steel Company, St. Louis, Mo.
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F. G. Bryan, St. Louis Ordnance District, St. Louis, Mo.
Kenneth A. Cavenah, Scott Base Air Field, Belleville, Ill.
Aaron Fisher, Universal Match Corporation, St. Louis, Mo.
Russell E. Gardner, Jr., Reinholdt & Gardner, St. Louis, Mo.
Stanley Jackes, Jackes-Evans Manufacturing Company, St. Louis, Mo.
Edward J. Judge, Scullin Steel Company, St. Louis, Mo.
John N. Marshall, Granite City Steel Company, Granite City, Ill.
Clyde H. Morgan, Emerson Electric Company, St. Louis, Mo.
Arden J. Mummert, McQuay-Norris Manufacturing Company, St. Louis, Mo.
Spencer T. Olin, Olin Industries, Inc., East Alton, Ill.

M. F. Peterson, Carter Carburetor Company, St. Louis, Mo.
Vincent P. Ring, Knapp-Monarch Company, St. Louis, Mo.
Walter Siegrist, Medart Company, St. Louis, Mo.

San Francisco Post, October 17, 1923

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Philip J. Fitzgerald, Dean Witter & Company, San Francisco, Calif.
Lawrence S. Fletcher, Piedmont, Calif.
G. M. Greenwood, Rheem Manufacturing Company, Richmond, Calif.
Carroll Hudson, Headquarters, Sixth Army, San Francisco, Calif.
George Murray, San Francisco, Calif.
Jean C. Witter, Dean Witter & Company, San Francisco, Calif.

Texas Post, October 30, 1942

President: W. O. Hedrick, McEvoy Company, Houston, Tex.
Vice-President: W. H. Miner, Lufkin Foundry & Machine Company, Houston, Tex.
Secretary-Treasurer: Leo S. Bassett, Department of the Army, Dickson Gun Plant, P. O. Box 2545, Houston, Tex.
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Phillip P. Krumb, Sr., Rheem Manufacturing Company, Houston, Tex.
O. L. Lorchn, Cameron Iron Works, Houston, Tex.
D. J. Martin, Hughes Tool Company, Houston, Tex.
R. D. Springer, Bellaire, Tex.

University of Michigan Post, February 20, 1941

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Vice-President: Jack C. Gillett, University of Michigan, Ann Arbor, Mich.
Secretary-Treasurer: Ronald Modlin, University of Michigan, Ann Arbor, Mich.
Directors: Clinton Harris, Argus Cameras, Inc., Ann Arbor, Mich.
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Washington Post, November 18, 1925

President: Ludlow King, Owens-Corning Fiberglas Corporation, Washington, D. C.
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Stanley A. Shank, Socony-Vacuum Oil Company, Washington, D. C.

Yankee Post, June 30, 1925

President: Harry A. Wansker, Carr Fastener Corporation, Cambridge, Mass.
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Elmer J. McVey, Saco-Lowell Shops, Biddeford, Me.
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L. J. Meyns, Babson Institute of Business Administration, Wellesley, Mass.
E. W. Miller, Fellows Gear Shaper Company, Springfield, Vt.
R. S. Morse, National Research Corporation, Cambridge, Mass.
G. P. Slade, Boston Ordnance District, Boston, Mass.
R. F. Williams, Associated Industries of Massachusetts, Boston, Mass.

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Technical Divisions and Committees of the Association are voluntary advisory groups of qualified personnel, organized primarily along commodity lines, to serve the ordnance organizations of the Army, Navy, and Air Force and other agencies of the national-defense establishment of the United States.

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(Continued on p. 22)

Organization of the Amer

Aberdeen Proving Ground

Birmingham

Capital Cities (Albany)

Central Illinois (Peoria)

Chicago

Cincinnati

The Citadel (Charleston, S. C.)

Cleveland

Columbia River (Portland, Oreg.)

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Jamestown Chapter (Jamestown)
Mohawk Valley Chapter (Utica)
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Southern Tier Chapter (Elmira)
Syracuse Chapter (Syracuse)
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- Small Arms Ammunition Committee
- Pistols and Revolvers Committee
- Caliber .50 and 20-mm. Steel Case Ammunition Committee
- 20-mm. Brass Cartridge Case Committee
- 20-mm. Projectile Committee

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THE AMERICAN ORDNANCE ASSOCIATION was organized in 1919 as the Army Ordnance Association and incorporated under the Laws of the District of Columbia in 1928. It became the American Ordnance Association January 1, 1948. It is a patriotic, educational, scientific, nonpolitical, and nonprofit-making organization of American citizens dedicated to scientific and industrial preparedness for the common defense as one of our Nation's strongest guaranties of security and peace.

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Working for Peace

SINCE its foundation in 1919, the American Ordnance Association has pledged its membership to assist in effecting industrial preparedness as our best available guaranty of peace. True, what it was able to accomplish between the two World Wars did not, in the final analysis, insure peace. Due to public apathy and in many cases to active hostility, all it was able to do was to shorten the war, save eighty per cent of our possible battle-death expectancy, and save civilization.

Now, the emergency is much greater. However, we have learned how to integrate our great industrial potential for the support of our armed forces, and how to convert peacetime activities into war-winning energy.

The American Ordnance Association through its Technical Divisions and Committees has undertaken, on a voluntary basis, when requested by governmental authority, to attempt the solution of quantity production problems confronting the ordnance organizations of the United States Army, the United States Navy, and the United States Air Force.

In brief, the armed forces design improved arms and vehicles. American industry through these technical committees seeks to develop practical methods for turning out ordnance faster, cheaper, requiring less labor, requiring less strategic material—if possible, all four.

We need to produce ordnance more quickly than ever before because, unlike the first two World Wars, no nation stands between us and the aggressor's initial onslaught. We are in greater and more immediate danger today than ever before in our history.

We need to manufacture weapons and vehicles more cheaply than ever before in order to avoid bankruptcy, economic chaos, and ultimate defeat. The cost is high even if we win—but the cost of defeat would be immeasurably higher.

We need to economize in man-hours of labor to a greater degree than ever before, because for the first time in our experience manpower may well prove to be the controlling factor in the whole program.

We need to conserve strategic materials, because we are now nearer to being a "have-not" nation than ever before.

The American way to achieve peace through strength is by voluntary coöperation of those best fitted to produce weapons and vehicles and fire-control systems and so forth down through the long list of thousands of different assembled units and hundreds of thousands of separate articles now officially designated as "ordnance."

The activities of the A.O.A. Technical Divisions and Committees require substantial expenditure of Association funds. These funds arise from two principal sources: first and most important, the dues of our members and, secondly, the revenue from advertisements in the official journal of the Association—ORDNANCE.

To meet this situation the Association welcomes the support of all those individual American citizens who sense that $10.00 for a 3-year membership is only "a penny a day to keep war away."

The American Ordnance Association offers a practical way for American citizens, and groups of American citizens, to pool their knowledge and energy in "Working for Peace."

Honor Roll of Industrial Preparedness

The Company Members of the American Ordnance Association whose names are on this roster are coöperating with the Association in its work for national security and peace. These Company Members, by nominating ten of their key employees for individual membership in the Association, form a nucleus of trained men who constitute a bulwark of preparedness for the national defense of the United States.

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AMERICAN BOX BOARD CO. . GRAND RAPIDS, MICH.
AMERICAN BOX CORPORATION SAN FRANCISCO, CALIF.
AMERICAN BRAKE SHOE COMPANY . NEW YORK, N.Y.
AMERICAN BRASS COMPANY . . WATERBURY, CONN.
AMERICAN BRIDGE DIVISION, U. S. STEEL COMPANY . . . . . PITTSBURGH, PA.
AMERICAN CAN COMPANY . . . . NEW YORK, N.Y.
AMERICAN CAR & FOUNDRY COMPANY NEW YORK, N.Y.
AMERICAN CAST IRON PIPE COMPANY BIRMINGHAM, ALA.
AMERICAN CHEMICAL PAINT COMPANY . AMBLER, PA.
AMERICAN-COLEMAN COMPANY . . OMAHA, NEBR.
AMERICAN CYSTOSCOPE MAKERS, INC. NEW YORK, N.Y.
AMERICAN DISTRICT STEAM COMPANY . . . . NORTH TONAWANDA, N. Y.
AMERICAN ELECTRIC FUSION CORPORATION . . . . . CHICAGO, ILL.
AMERICAN ELECTRIC SWITCH CORPORATION . . . . . MINERVA, OHIO
AMERICAN ELECTRICAL HEATER COMPANY . . . . . DETROIT, MICH.
AMERICAN ELECTRO METAL CORPORATION . . . . . YONKERS, N. Y.
AMERICAN FIXTURE & MANUFACTURING COMPANY . . . . . ST. LOUIS, MO.
AMERICAN FORGING & SOCKET COMPANY . . . . . PONTIAC, MICH.
AMERICAN HOSPITAL SUPPLY CORPORATION . . . . . EVANSTON, ILL.
AMERICAN INSTRUMENT CO., INC. SILVER SPRING, MD.
AMERICAN INSULATOR CORPORATION NEW FREEDOM, PA.
AMERICAN LIGHT ALLOYS, INC. . LITTLE FALLS, N. J.
AMERICAN LOCOMOTIVE COMPANY . NEW YORK, N.Y.
AMERICAN MACHINE & FOUNDRY COMPANY . . . . . NEW YORK, N.Y.
AMERICAN METAL PRODUCTS COMPANY DETROIT, MICH.
AMERICAN METER COMPANY . . PHILADELPHIA, PA.
AMERICAN PHENOLIC CORPORATION . CHICAGO, ILL.
AMERICAN PLATINUM WORKS . . . NEWARK, N.J.
AMERICAN RADIATOR & STANDARD SANITARY CORPORATION . . . . . PITTSBURGH, PA.
AMERICAN SAFETY RAZOR CORPORATION NEW YORK, N.Y.
AMERICAN SEATING COMPANY GRAND RAPIDS, MICH.
AMERICAN STAMPING COMPANY . . CLEVELAND, OHIO
AMERICAN STEEL & WIRE COMPANY CLEVELAND, OHIO
AMERICAN STEEL FOUNDRIES . . . CHICAGO, ILL.
AMERICAN TIME PRODUCTS, INC. . . NEW YORK, N.Y.
AMERICAN TYPE FOUNDERS, INC. . . ELIZABETH, N.J.
AMERICAN WELDING & MANUFACTURING COMPANY . . . . . WARREN, OHIO

Honor Roll of Industrial Preparedness

ANACONDA WIRE AND CABLE COMPANY NEW YORK, N.Y.
ANCHOR COUPLING COMPANY . . LIBERTYVILLE, ILL.
ANCHOR PACKING COMPANY . . PHILADELPHIA, PA.
ANCHOR POST PRODUCTS, INC. . . BALTIMORE, MD.
ANDERSON COMPANY . . . . . GARY, IND.
ANDERSON WOOD WORKING COMPANY LOUISVILLE, KY.
ANGIER CORPORATION . . . . FRAMINGHAM, MASS.
ANHEUSER-BUSCH, INC. . . . . ST. LOUIS, MO.
ANIMAL TRAP COMPANY OF AMERICA . LITITZ, PA.
ANSUL CHEMICAL COMPANY . . . MARINETTE, WIS.
APPROVED MANUFACTURING CO. . FARMINGTON, MICH.
ARGUS CAMERAS, INC. . . . . ANN ARBOR, MICH.
ARMA CORPORATION . . . . . NEW YORK, N.Y.
ARMCO STEEL CORPORATION . . MIDDLETOWN, OHIO
ARMOUR RESEARCH FOUNDATION . CHICAGO, ILL.
ARMSTRONG CORK COMPANY . . . LANCASTER, PA.
ARMSTRONG RUBBER COMPANY . WEST HAVEN, CONN.
ARNOLD ENGINEERING COMPANY . . MARENGO, ILL.
ARNOLT CORPORATION . . . . WARSAW, IND.
ARO EQUIPMENT CORPORATION . . . BRYAN, OHIO
ART METAL CONSTRUCTION COMPANY JAMESTOWN, N.Y.
ARVIN INDUSTRIES, INC. . . . . COLUMBUS, IND.
ASSOCIATED SPRING CORPORATION . BRISTOL, CONN.
ATKINS AND COMPANY, E. C. . . INDIANAPOLIS, IND.
ATLANTIC INDIA RUBBER WORKS, INC. CHICAGO, ILL.
ATLAS DROP FORGE COMPANY . . LANSING, MICH.
ATLAS FOUNDRY COMPANY . . . DETROIT, MICH.
ATLAS POWDER COMPANY . . . WILMINGTON, DEL.
AULD COMPANY, D. L. . . . . COLUMBUS, OHIO
AUSTERBERRY'S SONS, J. C. . . . DETROIT, MICH.
AUSTIN POWDER COMPANY . . . CLEVELAND, OHIO
AUTO SPECIALTIES MANUFACTURING COMPANY . . . . . .ST. JOSEPH, MICH.
AUTOCAR COMPANY . . . . . ARDMORE, PA.
AUTOMATIC MACHINE PRODUCTS COMPANY . . . . . ATTLEBORO, MASS.
AUTOMATIC STEEL PRODUCTS, INC. . CANTON, OHIO
AUTOMOTIVE FABRICATORS, INC. . . DETROIT, MICH.
AUTOMOTIVE MATERIALS CORPORATION DETROIT, MICH.
AUTOMOTIVE RUBBER COMPANY . . DETROIT, MICH.
AUTOMOTIVE SOLVENTS & SPECIALTIES, INC. . . ST. CLAIR SHORES, MICH.

BADGER METER MANUFACTURING COMPANY . . . . . MILWAUKEE, WIS.
BAGLEY & SEWELL COMPANY . . WATERTOWN, N.Y.
BAILEY PRODUCTS CORPORATION . . UNION CITY, IND.
BAIRD ASSOCIATES, INC. . . . CAMBRIDGE, MASS.
BAKER & COMPANY, INC. . . . . NEWARK, N.J.
BAKER & COMPANY, HUGH J. . . INDIANAPOLIS, IND.
BAKER OIL TOOLS, INC. . . . LOS ANGELES, CALIF.
BALDWIN COMPANY . . . . CINCINNATI, OHIO
BALDWIN-LIMA-HAMILTON CORPORATION . . . . . PHILADELPHIA, PA.
BALTIMORE AND OHIO RAILROAD COMPANY . . . . . BALTIMORE, MD.
BALTIMORE STEEL WORKS . . . . BALTIMORE, MD.
BARDEN CORPORATION . . . . DANBURY, CONN.
BARIUM STEEL CORPORATION . . . NEW YORK, N.Y.
BARNES COMPANY, W. F. & JOHN . . ROCKFORD, ILL.
BARTEL, THOMAS H. . . . . DETROIT, MICH.
BASALT ROCK COMPANY . . . . . NAPA, CALIF.
BASTIAN-BLESSING COMPANY . . . CHICAGO, ILL.
BASTIAN-MORLEY COMPANY . . . LA PORTE, IND.
BATH & COMPANY, JOHN . . . WORCESTER, MASS.
BAUER BROTHERS COMPANY . . SPRINGFIELD, OHIO
BAUSCH & LOMB OPTICAL COMPANY . ROCHESTER, N.Y.
BAYLEY COMPANY, WILLIAM . . SPRINGFIELD, OHIO
BEAIRD COMPANY, J. B. . . . . SHREVEPORT, LA.
BEAN DIVISION, JOHN, FOOD MACHINERY & CHEMICAL CORPORATION . . . LANSING, MICH.
BEAR MANUFACTURING COMPANY ROCK ISLAND, ILL.
BEHR-MANNING CORPORATION . . . TROY, N.Y.
BELL TELEPHONE COMPANY OF PENNSYLVANIA . . . . . PHILADELPHIA, PA.
BELL TELEPHONE LABORATORIES, INC. NEW YORK, N.Y.
BELLE CITY MALLEABLE IRON COMPANY RACINE, WIS.
BELOIT IRON WORKS . . . . . BELOIT, WIS.
BENDIX AVIATION CORPORATION . . DETROIT, MICH.
BENDIX-WESTINGHOUSE AUTOMOTIVE AIR BRAKE COMPANY . . . . . ELYRIA, OHIO
BENEDICT-MILLER, INC. . . . . NEWARK, N.J.
BERYLLIUM CORPORATION . . . . READING, PA.
BETHLEHEM STEEL COMPANY . . . BETHLEHEM, PA.
BETTER BRUSHES, INC. . . . . PALMER, MASS.
BETTINGER CORPORATION . . . . WALTHAM, MASS.
B G CORPORATION . . . . . NEW YORK, N. Y.
BIEDERMAN MOTORS CORPORATION . CINCINNATI, OHIO
BIRD & SON, INC. . . . . EAST WALPOLE, MASS.
BIRDSBORO STEEL FOUNDRY & MACHINE COMPANY . . . . . BIRDSBORO, PA.
BIRMINGHAM PAPER COMPANY . BIRMINGHAM, ALA.
BIRTMAN ELECTRIC COMPANY . . . CHICAGO, ILL.
BLACK & DECKER MANUFACTURING COMPANY . . . . . TOWSON, MD.
BLACK-CLAWSON COMPANY . . . HAMILTON, OHIO
BLACKMER PUMP COMPANY . GRAND RAPIDS, MICH.
BLACKSTONE CORPORATION . . JAMESTOWN, N.Y.
BLANCHARD MACHINE COMPANY . CAMBRIDGE, MASS.
BLAW-KNOX COMPANY . . . . BLAWNOX, PA.
BLISS COMPANY, E. W. . . . . .CANTON, OHIO
BOEING AIRPLANE COMPANY . . . SEATTLE, WASH.
BOHN ALUMINUM & BRASS CORPORATION . . . . . DETROIT, MICH.
BORG CORPORATION, GEO. W. . . . DELAVAN, WIS.
BORG-WARNER CORPORATION . . . CHICAGO, ILL.
BOSTITCH, INC. . . . . WESTERLY, R.I.
BOTANY MILLS . . . . . PASSAIC, N.J.
BOUND BROOK OIL-LESS BEARING COMPANY . . . . . BOUND BROOK, N.J.
BOUTELL DRIVEAWAY COMPANY, F. J. DETROIT, MICH.
BOWEN & MCLAUGHLIN . . . . PHOENIX, ARIZ.
BOWER ROLLER BEARING COMPANY . DETROIT, MICH.
BOWSER, INC. . . . . FORT WAYNE, IND.
BOYERTOWN AUTO BODY WORKS . . BOYERTOWN, PA.
BREEZE CORPORATIONS, INC. . . . NEWARK, N.J.
BREWSTER COMPANY . . . . . SHREVEPORT, LA.
BRIDGEPORT BRASS COMPANY . . BRIDGEPORT, CONN.
BRIDGEPORT ROLLING MILLS CO. . BRIDGEPORT, CONN.
BRIGGS & STRATTON CORPORATION MILWAUKEE, WIS.
BRIGGS MANUFACTURING COMPANY . DETROIT, MICH.
BRIGHTON SCREW & MANUFACTURING COMPANY . . . . . CINCINNATI, OHIO
BRILLO MANUFACTURING COMPANY . NEW YORK, N.Y.

Honor Roll of Industrial Preparedness

BRISKIN MANUFACTURING COMPANY . . CHICAGO, ILL.
BRISTOL MACHINE TOOL COMPANY FORESTVILLE, CONN.
BRISTOL-MYERS COMPANY . . . . NEW YORK, N.Y.
BROEN METAL PRODUCTS, INC. . . DETROIT, MICH.
BROOK & PERKINS . . . . . DETROIT, MICH.
BROWN & BIGELOW . . . . . ST. PAUL, MINN.
BROWN & ROOT, INC. . . . . HOUSTON, TEX.
BROWN & SHARPE MANUFACTURING COMPANY . . . . . PROVIDENCE, R.I.
BRYANT CHUCKING GRINDER COMPANY SPRINGFIELD, VT.
BUCKEYE IRON & BRASS WORKS . . DAYTON, OHIO
BUCKEYE STEEL CASTINGS COMPANY COLUMBUS, OHIO
BUCKINGHAM MANUFACTURING COMPANY . . . . . BINGHAMTON, N.Y.
BUCYRUS-ERIE COMPANY . SOUTH MILWAUKEE, WIS.
BUDD COMPANY . . . . . DETROIT, MICH.
BUDD COMPANY . . . . . PHILADELPHIA, PA.
BUICK MOTOR DIVISION, GMC . . . . FLINT, MICH.
BUICK-OLDSMOBILE-PONTIAC ASSEMBLY DIVISION, GMC . . . . . SOUTH GATE, CALIF.
BUILDERS IRON FOUNDRY . . . PROVIDENCE, R.I.
BUILDERS STRUCTURAL STEEL CORPORATION . . . . . CLEVELAND, OHIO
BULLDOG ELECTRIC PRODUCTS COMPANY DETROIT, MICH.
BULOVA WATCH COMPANY . . . NEW YORK, N.Y.
BUNDY TUBING COMPANY . . . . DETROIT, MICH.
BUNTING GLIDER COMPANY . . PHILADELPHIA, PA.
BURGESS-NORTON MFG. COMPANY . . GENEVA, ILL.
BURKE COMPANY, O. W. . . . . DETROIT, MICH.
BURLINGTON BRASS WORKS . . BURLINGTON, WIS.
BURNDY ENGINEERING COMPANY . . NORWALK, CONN.
BURROUGHS ADDING MACHINE CO. . DETROIT, MICH.
BURT COMPANY, F. N. . . . . BUFFALO, N.Y.
BUSCHMAN COMPANY, E. W. . . CINCINNATI, OHIO
BUTTERWORTH & SONS COMPANY, H. W. BETH AYRES, PA.
BYERS COMPANY, A. M. . . . . PITTSBURGH, PA.

CADILLAC MALLEABLE IRON COMPANY CADILLAC, MICH.
CADILLAC MOTOR CAR DIVISION, GMC DETROIT, MICH.
CADILLAC MOTOR CAR DIVISION, GMC, CLEVELAND TANK PLANT . . CLEVELAND, OHIO
CADILLAC PRODUCTS, INC. . . . FERNDALE, MICH.
CALLAHAN CAN MACHINE COMPANY BROOKLYN, N. Y.
CAMERON IRON WORKS, INC. . . . HOUSTON, TEX.
CAMPBELL CHAIN COMPANY . . . . YORK, PA.
CAMPBELL, WYANT AND CANNON FOUNDRY COMPANY . . . . . MUSKEGON, MICH.
CANFIELD RUBBER COMPANY . . BRIDGEPORT, CONN.
CANS, INCORPORATED . . . . . CHICAGO, ILL.
CARBOLOY COMPANY . . . . . DETROIT, MICH.
CARBORUNDUM COMPANY . . . NIAGARA FALLS, N.Y.
CAREY-MCFALL COMPANY . . . PHILADELPHIA, PA.
CARRIER CORPORATION . . . . SYRACUSE, N.Y.
CARTER CARBURETOR CORPORATION . ST. LOUIS, MO.
CASE COMPANY, J. I. . . . . RACINE, WIS.
CATAWISSA VALVE & FITTINGS COMPANY CATAWISSA, PA.
CATERPILLAR TRACTOR CO. . . . . PEORIA, ILL.
C. E. M. COMPANY . . . . . DAYVILLE, CONN.
CENTRAL BOILER & MANUFACTURING CO. DETROIT, MICH.
CENTRAL CAN COMPANY . . . . CHICAGO, ILL.
CENTRAL FOUNDRY COMPANY . . NEWARK, N.J.
CENTRIFIX CORPORATION . . . . CLEVELAND, OHIO
CENTURY ELECTRIC COMPANY . . ST. LOUIS, MO.
CENTURY ENGINEERING CORPORATION . . . . . CEDAR RAPIDS, IOWA
CHAIN BELT COMPANY . . . . MILWAUKEE, WIS.
CHAMBERSBURG ENGINEERING COMPANY . . . . . CHAMBERSBURG, PA.
CHAMPION SPARK PLUG COMPANY . TOLEDO, OHIO
CHANCE COMPANY, A. B. . . . . CENTRALIA, MO.
CHASE BRASS & COPPER COMPANY WATERBURY, CONN.
CHECKER CAB MANUFACTURING CORPORATION . . . . . KALAMAZOO, MICH.
CHEFFORD MASTER MANUFACTURING COMPANY . . . . . FAIRFIELD, ILL.
CHEMICAL CONSTRUCTION CORPORATION . . . . . NEW YORK, N.Y.
CHEVROLET MOTOR DIVISION, GMC . DETROIT, MICH.
CHICAGO EXTRUDED METALS COMPANY . CICERO, ILL.
CHICAGO RAILWAY EQUIPMENT COMPANY CHICAGO, ILL.
CHICAGO RAWHIDE MANUFACTURING COMPANY . . . . . CHICAGO, ILL.
CHIKSAN COMPANY . . . . . BREA, CALIF.
CHIPMAN KNITTING MILLS . . . . EASTON, PA.
CHRISTMAN COMPANY . . . . . LANSING, MICH.
CHRYSLER CORPORATION . . . . DETROIT, MICH.
CHRYSLER MOTOR PARTS CORPORATION DETROIT, MICH.
CHRYSLER SALES CORPORATION . . DETROIT, MICH.
CINCINNATI MILLING MACHINE COMPANY . . . . . CINCINNATI, OHIO
CITIZENS MORTGAGE CORPORATION . DETROIT, MICH.
CLARK CABLE CORPORATION . . CLEVELAND, OHIO
CLARK EQUIPMENT COMPANY . . BUCHANAN, MICH.
CLARK GRAVE VAULT COMPANY . . COLUMBUS, OHIO
CLARK MANUFACTURING COMPANY, J. L. ROCKFORD, ILL.
CLARY MULTIPLIER CORPORATION SAN GABRIEL, CALIF.
CLAYTON MANUFACTURING COMPANY EL MONTE, CALIF.
CLEARING MACHINE CORPORATION . CHICAGO, ILL.
CLEAVER-BROOKS COMPANY . . MILWAUKEE, WIS.
CLEVELAND CONTAINER COMPANY . CLEVELAND, OHIO
CLEVELAND GRAPHITE BRONZE COMPANY . . . . . CLEVELAND, OHIO
CLEVELAND HARDWARE & FORGING COMPANY . . . . . CLEVELAND, OHIO
CLEVELAND HOBBING MACHINE COMPANY EUCLID, OHIO
CLEVELAND PNEUMATIC TOOL COMPANY . . . . . CLEVELAND, OHIO
CLEVELAND STEEL BARREL COMPANY CLEVELAND, OHIO
CLEVELAND STEEL PRODUCTS CORPORATION . . . . . CLEVELAND, OHIO
CLEVELAND TWIST DRILL COMPANY CLEVELAND, OHIO
CLEVELAND WELDING COMPANY . . CLEVELAND, OHIO
CLIFFORD MANUFACTURING COMPANY, DIVISION OF STANDARD-THOMSON CORPORATION . . . . . WALTHAM, MASS.
CLIMAX MOLYBDENUM COMPANY . . NEW YORK, N.Y.
CLOVER MANUFACTURING COMPANY NORWALK, CONN.
COBUSCO STEEL PRODUCTS . . . DENVER, COLO.
COCA-COLA COMPANY . . . . . ATLANTA, GA.
COHOES ENVELOPE COMPANY, INC. . . COHOES, N.Y.
COLE LABORATORIES, INC. . LONG ISLAND CITY, N.Y.
COLLINS RADIO COMPANY . . . CEDAR RAPIDS, IOWA
COLONIAL BROACH COMPANY . . . DETROIT, MICH.
COLORADO FUEL & IRON CORPORATION DENVER, COLO.

Honor Roll of Industrial Preparedness

COLSON CORPORATION . . . . . ELYRIA, OHIO
COLT'S MANUFACTURING COMPANY HARTFORD, CONN.
COLUMBUS BOLT & FORGING CO. . . COLUMBUS, OHIO
COMMERCIAL BARGE LINES, INC. . . DETROIT, MICH.
COMMERCIAL CARRIERS, INC. . . . DETROIT, MICH.
COMMERCIAL SOLVENTS CORPORATION NEW YORK, N.Y.
COMMERCIAL STEEL TREATING CORP. . DETROIT, MICH.
CONE AUTOMATIC MACHINE COMPANY . WINDSOR, VT.
CONMAR PRODUCTS CORPORATION . NEWARK, N.J.
CONNER TOOL & CUTTER COMPANY . DETROIT, MICH.
CONSOLIDATED ENGINEERING CORPORATION . . . . . PASADENA, CALIF.
CONSOLIDATED IRON-STEEL MANUFACTURING COMPANY . . . . . CLEVELAND, OHIO
CONSOLIDATED NATURAL GAS COMPANY NEW YORK, N.Y.
CONTAINER CORPORATION OF AMERICA CHICAGO, ILL.
CONTINENTAL AVIATION & ENGINEERING CORPORATION . . . . . DETROIT, MICH.
CONTINENTAL CAN COMPANY . . . NEW YORK, N.Y.
CONTINENTAL COPPER & STEEL INDUSTRIES, INC. . . . . NEW YORK, N.Y.
CONTINENTAL FOUNDRY AND MACHINE COMPANY . . . . . EAST CHICAGO, IND.
CONTINENTAL MOTORS CORPORATION DETROIT, MICH.
CONTINENTAL RUBBER WORKS . . . . ERIE, PA.
CONTROL INSTRUMENT COMPANY . . NEW YORK, N.Y.
COOK PAINT & VARNISH COMPANY . DETROIT, MICH.
COPCO STEEL & ENGINEERING COMPANY DETROIT, MICH.
COPPERWELD STEEL COMPANY . . WARREN, OHIO
CORNING GLASS WORKS . . . . CORNING, N.Y.
CORO, INC. . . . . PROVIDENCE, R.I.
COSA CORPORATION . . . . . NEW YORK, N.Y.
COUCH COMPANY, S. H. . . NORTH QUINCY, MASS.
CRANE COMPANY . . . . . CHICAGO, ILL.
CRESCENT BRASS & PIN COMPANY . DETROIT, MICH.
CRIBBEN AND SEXTON COMPANY . . CHICAGO, ILL.
CRONAME, INC. . . . . CHICAGO, ILL.
CROSLEY DIVISION, AVCO MANUFACTURING CORPORATION . . . . . CINCINNATI, OHIO
CROSLEY MOTORS, INC. . . . CINCINNATI, OHIO
CROSS COMPANY . . . . . DETROIT, MICH.
CROWN CAN COMPANY . . . PHILADELPHIA, PA.
CROWN CORK & SEAL COMPANY . . BALTIMORE, MD.
CUMMINS ENGINE COMPANY . . . COLUMBUS, IND.
CURRAN COMPANY, FRANK J. . DOWNERS GROVE, ILL.
CUSHMAN MOTOR WORKS . . . . LINCOLN, NEBR.
CUTLER-HAMMER, INC. . . . MILWAUKEE, WIS.

DACO MACHINE TOOL COMPANY . . NEW YORK, N.Y.
DALTON FOUNDRIES, INC. . . . . WARSAW, IND.
DANLY MACHINE SPECIALTIES, INC. . CHICAGO, ILL.
DARBY PRODUCTS OF STEEL PLATE CORPORATION . . . . . KANSAS CITY, KANS.
DARBYSHIRE STEEL COMPANY . . . . EL PASO, TEX.
DARLING VALVE & MANUFACTURING COMPANY . . . . . WILLIAMSPORT, PA.
DAVISON CHEMICAL CORPORATION . BALTIMORE, MD.
DAY & ZIMMERMANN, INC. . . PHILADELPHIA, PA.
DAYSTROM ELECTRIC CORPORATION POUGHKEEPSIE, N.Y.
DAYTON MALLEABLE IRON COMPANY . DAYTON, OHIO
DAYTON RUBBER COMPANY . . . DAYTON, OHIO
DAYTON STEEL FOUNDRY COMPANY . DAYTON, OHIO
DAZEY CORPORATION . . . . . .ST. LOUIS, MO.
DEARBORN CHEMICAL COMPANY . . CHICAGO, ILL.
DEARBORN MOTORS CORPORATION . DETROIT, MICH.
DEARBORN STOVE COMPANY . . . . DALLAS, TEX.
DEERE & COMPANY . . . . . MOLINE, ILL.
DEFIANCE AUTOMATIC SCREW COMPANY. . . . . DEFIANCE, OHIO
DELCO PRODUCTS DIVISION, GMC . . DAYTON, OHIO
DELTA TANK MANUFACTURING COMPANY, INC. . . . . BATON ROUGE, LA.
DENISON ENGINEERING COMPANY . COLUMBUS, OHIO
DERRICK & HOIST COMPANY LONG ISLAND CITY, N. Y.
DE SANNO & SON, INC., A. P. . . PHOENIXVILLE, PA.
DE SOTO MOTOR CORPORATION . . DETROIT, MICH.
DETREX CORPORATION . . . . DETROIT, MICH.
DETROIT ALUMINUM AND BRASS CORPORATION . . . . . DETROIT, MICH.
DETROIT AUTOMOTIVE PRODUCTS CORPORATION . . . . . DETROIT, MICH.
DETROIT BRASS & MALLEABLE WORKS DETROIT, MICH.
DETROIT CHEMICAL SPECIALTIES, INC. DETROIT, MICH.
DETROIT DIESEL ENGINE DIVISION, GMC DETROIT, MICH.
DETROIT EDISON COMPANY . . . DETROIT, MICH.
DETROIT GASKET & MANUFACTURING COMPANY . . . . . DETROIT, MICH.
DETROIT GEAR DIVISION, BORG-WARNER CORPORATION . . . . . DETROIT, MICH.
DETROIT GRAY IRON FOUNDRY COMPANY DETROIT, MICH.
DETROIT HARVESTER COMPANY . . DETROIT, MICH.
DETROIT LUBRICATOR COMPANY . . DETROIT, MICH.
DETROIT-MICHIGAN STOVE COMPANY . DETROIT, MICH.
DETROIT PLATING INDUSTRIES . . DETROIT, MICH.
DETROIT STAMPING COMPANY . . . DETROIT, MICH.
DETROIT STEEL CORPORATION . . DETROIT, MICH.
DETROIT STEEL PRODUCTS COMPANY . DETROIT, MICH.
DETROIT TRANSMISSION DIVISION, GMC DETROIT, MICH.
DEVLIEG MACHINE COMPANY . . . FERNDALE, MICH.
DEXTER COMPANY . . . . . FAIRFIELD, IOWA
DIAMOND MATCH COMPANY . . . NEW YORK, N.Y.
DIAMOND T MOTOR CAR COMPANY . CHICAGO, ILL.
DICK COMPANY, A. B. . . . . CHICAGO, ILL.
DICKEY & SONS, INC., W. J. . . . . OELLA, MD.
DIESEL EQUIPMENT DIVISION, GMC GRAND RAPIDS, MICH.
DISSTON & SONS, INC., HENRY . PHILADELPHIA, PA.
DIVCO CORPORATION . . . . . DETROIT, MICH.
DOALL COMPANY . . . . . DES PLAINES, ILL.
DODGE BROTHERS CORPORATION . . DETROIT, MICH.
DOELCAM CORPORATION . . . . NEWTON, MASS.
DOERR ELECTRIC CORPORATION . . CEDARBURG, WIS.
DOUGLAS AIRCRAFT COMPANY SANTA MONICA, CALIF.
DOUGLAS & LOMASON COMPANY . . DETROIT, MICH.
DOUGLAS TOOL COMPANY . . . . DETROIT, MICH.
DOWAGIAC STEEL FURNACE COMPANY DOWAGIAC, MICH.
DRAPER CORPORATION . . . . HOPEDALE, MASS.
DRAPER MOTORS CORPORATION . CENTERLINE, MICH.
DRAVO CORPORATION . . . . . PITTSBURGH, PA.
DRUGE BROTHERS MANUFACTURING COMPANY . . . . . OAKLAND, CALIF.
DUAL-MOTORS CORPORATION . . . DETROIT, MICH.
DUNCAN ELECTRIC MANUFACTURING COMPANY . . . . . LAFAYETTE, IND.
DUNHAM COMPANY, C. A. . . . . CHICAGO, ILL.

Honor Roll of Industrial Preparedness

DU PONT DE NEMOURS & COMPANY, E. I. . . . . WILMINGTON, DEL.
DURHAM MANUFACTURING CORPORATION MUNCIE, IND.
DURIRON COMPANY . . . . . DAYTON, OHIO
DUTTON-LAINSON COMPANY . . . HASTINGS, NEBR.

E & L TRANSPORT COMPANY . . DEARBORN, MICH.
EAGLE TOOL & MACHINE COMPANY .SPRINGFIELD, OHIO
EAST COAST AERONAUTICS, INC. . . .PELHAM, N. Y.
EASTERN STAINLESS STEEL CORP. . BALTIMORE, MD.
EASTERN TOOL & MANUFACTURING COMPANY . . . . . BELLEVILLE, N.J.
EASTMAN KODAK COMPANY . . . ROCHESTER, N.Y.
EASY WASHING MACHINE CORPORATION SYRACUSE, N.Y.
EATON MANUFACTURING COMPANY CLEVELAND, OHIO
EDGEWATER STEEL COMPANY . . . PITTSBURGH, PA.
EDISON, INC., THOMAS A. . . . . WEST ORANGE, N.J.
EDNALITE OPTICAL COMPANY . . . PEEKSKILL, N.Y.
EKCO PRODUCTS COMPANY . . . CHICAGO, ILL.
ELASTIC STOP NUT CORPORATION OF AMERICA . . . . . UNION, N.J.
ELECTRIC AUTO-LITE COMPANY . . . TOLEDO, OHIO
ELECTRIC FURNACE COMPANY . . . SALEM, OHIO
ELECTRIC SPRAYIT COMPANY . . . SHEBOYGAN, WIS.
ELECTRIC STORAGE BATTERY COMPANY . . . . . PHILADELPHIA, PA.
ELECTRICAL ENGINEERING AND MANUFACTURING CORPORATION . . . . . LOS ANGELES, CALIF.
ELECTRICAL REACTANCE CORPORATION . OLEAN, N.Y.
ELECTRO REFRACTORIES & ABRASIVES CORPORATION . . . . . BUFFALO, N.Y.
ELECTROL, INCORPORATED . . . KINGSTON, N.Y.
ELGIN NATIONAL WATCH COMPANY . . ELGIN, ILL.
ELKAY MANUFACTURING COMPANY . CHICAGO, ILL.
ELLIOTT COMPANY . . . . . JEANNETTE, PA.
ELLWOOD CITY FORGE COMPANY ELLWOOD CITY, PA.
EMERSON ELECTRIC MANUFACTURING COMPANY . . . . . ST. LOUIS, MO.
EMERSON RADIO & PHONOGRAPH CORPORATION . . . . . NEW YORK, N.Y.
EMPIRE COIL COMPANY . . . NEW ROCHELLE, N.Y.
EMSCO DERRICK & EQUIPMENT COMPANY . . . . . LOS ANGELES, CALIF.
ENGINEERING RESEARCH INSTITUTE, UNIVERSITY OF MICHIGAN . . . . . ANN ARBOR, MICH.
ENGINEERS SPECIALTIES DIVISION, UNIVERSAL ENGINEERING & COLORPLATE COMPANY . . . . . BUFFALO, N.Y.
ENGLANDER COMPANY . . . . . CHICAGO, ILL.
ENTERPRISE MANUFACTURING COMPANY AKRON, OHIO
ENTERPRISE TOOL & GEAR CORPORATION DETROIT, MICH.
ERIE RESISTOR CORPORATION . . . . . ERIE, PA.
ESSEX BRASS CORPORATION . . . DETROIT, MICH.
ESSO STANDARD OIL COMPANY . . NEW YORK, N.Y.
ESTATE STOVE COMPANY, DIVISION NOMA ELECTRIC CORPORATION . . . HAMILTON, OHIO
EVANS CASE COMPANY . NORTH ATTLEBORO, MASS.
EVANS PRODUCTS COMPANY . . PLYMOUTH, MICH.
EVANS' SONS, INC., JOHN . . . PHILADELPHIA, PA.
EX-CELL-O CORPORATION . . . . DETROIT, MICH.
EXACT WEIGHT SCALE COMPANY . . COLUMBUS, OHIO
EXOLON COMPANY . . . . . TONAWANDA, N.Y.

FABRICON PRODUCTS, INC. . . RIVER ROUGE, MICH.
FAFNIR BEARING COMPANY . NEW BRITAIN, CONN.
FAIRBANKS COMPANY . . . . . NEW YORK, N.Y.
FAIRCHILD ENGINE & AIRPLANE CORPORATION . . . . . FARMINGDALE, N.Y.
FALK CORPORATION . . . . . MILWAUKEE, WIS.
FALSTROM COMPANY . . . . . PASSAIC, N.J.
FANSTEEL METALLURGICAL CORPORATION . . . . . NORTH CHICAGO, ILL.
FARBER, INC., S. W. . . . . NEW YORK, N.Y.
FARGO MOTOR CORPORATION . . . DETROIT, MICH.
FARQUHAR COMPANY, A. B. . . . . YORK, PA.
FARRAND OPTICAL COMPANY . . . NEW YORK, N.Y.
FARREL-BIRMINGHAM COMPANY . . ANSONIA, CONN.
FASCO INDUSTRIES, INC. . . . . ROCHESTER, N.Y.
FAYSCOTT CORPORATION . . . . DEXTER, MAINE
FEDDERS-QUIGAN CORPORATION . . BUFFALO, N.Y.
FEDERAL DROP FORGE COMPANY . . LANSING, MICH.
FEDERAL ELECTRIC PRODUCTS COMPANY . NEWARK, N.J.
FEDERAL LABORATORIES, INC. . . PITTSBURGH, PA.
FEDERAL MOTOR TRUCK COMPANY . DETROIT, MICH.
FEDERAL SCREW WORKS . . . . DETROIT, MICH.
FEDERAL TELEPHONE AND RADIO CORPORATION . . . . . CLIFTON, N.J.
FELLOWS GEAR SHAPER COMPANY . SPRINGFIELD, VT.
FELT AND TARRANT MANUFACTURING CO. CHICAGO, ILL.
FERGUSON, INC., HARRY . . . . DETROIT, MICH.
FERRACUTE MACHINE COMPANY . . BRIDGETON, N.J.
FERRO MACHINE & FOUNDRY, INC. . CLEVELAND, OHIO
FERRO STAMPING AND MANUFACTURING COMPANY . . . . . DETROIT, MICH.
FIDELITY-PHILADELPHIA TRUST CO. PHILADELPHIA, PA.
FIFTH THIRD UNION TRUST COMPANY CINCINNATI, OHIO
FILER & STOWELL COMPANY . . MILWAUKEE, WIS.
FIRESTONE TIRE & RUBBER COMPANY . AKRON, OHIO
FIRST FEDERAL SAVINGS & LOAN ASSOCIATION OF DETROIT . . . . . DETROIT, MICH.
FIRTH STERLING, INC. . . . . PITTSBURGH, PA.
FISHER BODY DIVISION, GMC . . . LANSING, MICH.
FISHER-PRICE TOYS, INC. . . . EAST AURORA, N.Y.
FITZGIBBONS BOILER COMPANY . . NEW YORK, N.Y.
FITZSIMONS MANUFACTURING COMPANY DETROIT, MICH.
FLANNERY MANUFACTURING COMPANY BRIDGEVILLE, PA.
FLOUR CITY ORNAMENTAL IRON COMPANY . . . . . MINNEAPOLIS, MINN.
FLYNN MANUFACTURING COMPANY, MICHAEL . . . . . PHILADELPHIA, PA.
FOLLANSBEE STEEL CORPORATION . PITTSBURGH, PA.
FORD INSTRUMENT COMPANY, DIVISION OF SPERRY CORPORATION . . LONG ISLAND CITY, N.Y.
FORD MOTOR COMPANY . . . . . CHESTER, PA.
FORD MOTOR COMPANY . . . DEARBORN, MICH.
FORMSPRAG COMPANY . . . . . VAN DYKE, MICH.
FORT PITT MALLEABLE DIVISION, STEEL TRADING CORPORATION . . . PITTSBURGH, PA.
FOSTER WHEELER CORPORATION . . NEW YORK, N.Y.
FOUR WHEEL DRIVE AUTO COMPANY CLINTONVILLE, WIS.
FRAM CORPORATION . . . . PROVIDENCE, R.I.
FRANTZ COMPANY, S. G. . . . . TRENTON, N.J.
FRICK-GALLAGHER MFG. COMPANY . WELLSTON, OHIO
FRIGIDAIRE DIVISION, GMC . . . DAYTON, OHIO
FRUEHAUF TRAILER COMPANY . . DETROIT, MICH.

Honor Roll of Industrial Preparedness

FULLER BRUSH COMPANY . . . HARTFORD, CONN.
FULLER MANUFACTURING COMPANY KALAMAZOO, MICH.

GABRIEL COMPANY . . . . . CLEVELAND, OHIO
GAGE PRODUCTS COMPANY . . FERNDALE, MICH.
GAIR COMPANY, ROBERT . . . . NEW YORK, N.Y.
GALION ALLSTEEL BODY DIVISION, CENTRAL OHIO STEEL PRODUCTS COMPANY . . GALION, OHIO
GAR WOOD INDUSTRIES, INC. . . . WAYNE, MICH.
GARLAND MANUFACTURING COMPANY DETROIT, MICH.
GARRETT COMPANY, GEORGE K. . PHILADELPHIA, PA.
GATES RUBBER COMPANY . . . . DENVER, COLO.
GAZDA ENGINEERING . . . . PROVIDENCE, R.I.
GEAR GRINDING MACHINE COMPANY . DETROIT, MICH.
GEMMER MANUFACTURING COMPANY . DETROIT, MICH.
GENERAL AMERICAN TRANSPORTATION CORPORATION . . . . . CHICAGO, ILL.
GENERAL ANILINE & FILM CORPORATION . . . . . NEW YORK, N.Y.
GENERAL DYESTUFF CORPORATION . NEW YORK, N.Y.
GENERAL DYNAMICS CORPORATION . NEW YORK, N. Y.
GENERAL ELECTRIC COMPANY . . SCHENECTADY, N.Y.
GENERAL FIREPROOFING COMPANY YOUNGSTOWN, OHIO
GENERAL INDUSTRIES COMPANY . . ELYRIA, OHIO
GENERAL MALLEABLE CORPORATION WAUKESHA, WIS.
GENERAL METALFAB COMPANY . . . DALLAS, TEX.
GENERAL METALS CORPORATION SAN FRANCISCO, CALIF.
GENERAL MOTORS CORPORATION . . DETROIT, MICH.
GENERAL MOTORS TRUCK & COACH DIV., GMC . . . . . PONTIAC, MICH.
GENERAL RAILWAY SIGNAL COMPANY ROCHESTER, N.Y.
GENERAL STEEL CASTINGS CORP. . GRANITE CITY, ILL.
GENERAL STEEL PRODUCTS CORPORATION FLUSHING, N.Y.
GENERAL TEXTILE MILLS, INC. . . NEW YORK, N.Y.
GENERAL TIME CORPORATION . . . NEW YORK, N.Y.
GENERAL TIRE & RUBBER COMPANY . . AKRON, OHIO
GENEVA MODERN KITCHENS . . . . GENEVA, ILL.
GERITY-MICHIGAN CORPORATION . . ADRIAN, MICH.
GEROTOR MAY CORPORATION . . . BALTIMORE, MD.
GERSTENSLAGER COMPANY . . . WOOSTER, OHIO
GEUDER, PAESCHKE & FREY COMPANY MILWAUKEE, WIS.
GIANNINI & COMPANY, G. M. . . PASADENA, CALIF.
GIBBS MANUFACTURING & RESEARCH CORPORATION . . . . . JANESVILLE, WIS.
GIBSON REFRIGERATOR COMPANY . GREENVILLE, MICH.
GIDDINGS & LEWIS MACHINE TOOL COMPANY . . . . . FOND DU LAC, WIS.
GILBERT & BARKER MANUFACTURING COMPANY . . . . WEST SPRINGFIELD, MASS.
GILLETTE SAFETY RAZOR COMPANY . BOSTON, MASS.
GISHOLT MACHINE COMPANY . . . MADISON, WIS.
GIVEN MACHINERY COMPANY . . LOS ANGELES, CALIF.
GLEASON WORKS . . . . . ROCHESTER, N.Y.
GLIDDEN COMPANY . . . . . CLEVELAND, OHIO
GLOBE AMERICAN CORPORATION . . KOKOMO, IND.
GLOBE CORPORATION . . . . . CHICAGO, ILL.
GLOBE-UNION, INC. . . . . MILWAUKEE, WIS.
G. M. CO MANUFACTURING, INC. LONG ISLAND CITY, N.Y.
GOODRICH COMPANY, B. F. . . . . AKRON, OHIO
GOOD ROADS MACHINERY CORPORATION MINERVA, OHIO
GOODYEAR TIRE & RUBBER COMPANY . AKRON, OHIO
GORHAM MANUFACTURING COMPANY PROVIDENCE, R.I.
GORTON MACHINE COMPANY, GEO. . . RACINE, WIS.
GOSS PRINTING PRESS COMPANY . . CHICAGO, ILL.
GOULD-NATIONAL BATTERIES, INC. . ST. PAUL, MINN.
GRABLER MANUFACTURING CO. . CLEVELAND, OHIO
GRAFLEX, INC. . . . . ROCHESTER, N. Y.
GRAMMES AND SONS, INC., L. F. . . ALLENTOWN, PA.
GRAND RAPIDS BRASS COMPANY GRAND RAPIDS, MICH.
GRANITE CITY STEEL COMPANY . GRANITE CITY, ILL.
GRAY MARINE MOTOR COMPANY . . DETROIT, MICH.
GREAT LAKES SPRING DIV., STANDARD STEEL SPRING CO. . . . . CHICAGO, ILL.
GREAT LAKES STEEL CORPORATION . DETROIT, MICH.
GREEN COLONIAL FURNACE CO. . DES MOINES, IOWA
GREENFIELD TAP AND DIE CORPORATION . . . . . GREENFIELD, MASS.
GREENVILLE STEEL CAR COMPANY . GREENVILLE, PA.
GREER COMPANY, J. W. . . . CAMBRIDGE, MASS.
GREER HYDRAULICS, INC. . . . . BROOKLYN, N. Y.
GREIST MANUFACTURING COMPANY NEW HAVEN, CONN.
GROOV-PIN CORPORATION . . . . UNION CITY, N.J.
GROTE MANUFACTURING COMPANY . BELLEVUE, KY.
GRUEN WATCH COMPANY . . . CINCINNATI, OHIO
GULF OIL CORPORATION . . . . PITTSBURGH, PA.
GURLEY, W. & L. E. . . . . TROY, N.Y.

HAGAN CORPORATION . . . . . PITTSBURGH. PA.
HALLETT MANUFACTURING COMPANY . . . . . INGLEWOOD, CALIF.
HALOID COMPANY . . . . . ROCHESTER, N.Y.
HAMILTON FOUNDRY & MACHINE COMPANY . . . . . HAMILTON, OHIO
HAMILTON MANUFACTURING CORPORATION . . . . . COLUMBUS, IND.
HAMILTON METAL PRODUCTS CO. . . HAMILTON, OHIO
HAMILTON WATCH COMPANY . . . LANCASTER, PA.
HANCOCK MANUFACTURING COMPANY JACKSON, MICH.
HANDY & HARMAN . . . . . NEW YORK, N.Y.
HANLON & GOODMAN COMPANY . . BELLEVILLE, N.J.
HANNIFIN CORPORATION . . . . CHICAGO, ILL.
HANSON-VAN WINKLE-MUNNING COMPANY . . . . . MATAWAN, N.J.
HARDY MANUFACTURING CORPORATION . . . . . PENDLETON, IND.
HARNISCHFEGER CORPORATION . MILWAUKEE, WIS.
HARRINGTON & RICHARDSON ARMS COMPANY . . . . . WORCESTER, MASS.
HARRIS FOUNDRY & MACHINE COMPANY CORDELE, GA.
HARRIS-SEYBOLD COMPANY . . CLEVELAND, OHIO
HARRISBURG STEEL CORPORATION HARRISBURG, PA.
HARSHAW CHEMICAL COMPANY . CLEVELAND, OHIO
HARVEY MACHINE COMPANY . . TORRANCE, CALIF.
HATZEL & BUEHLER, INC. . . . . DETROIT, MICH.
HAYES INDUSTRIES, INC. . . . . JACKSON, MICH.
HAYS MANUFACTURING COMPANY . . . ERIE, PA.
HECKETHORN MANUFACTURING & SUPPLY COMPANY . . . . . LITTLETON, COLO.
HEIL COMPANY . . . . . MILWAUKEE, WIS.
HEINEMANN ELECTRIC COMPANY . . TRENTON, N.J.
HEINTZ MANUFACTURING COMPANY PHILADELPHIA, PA.
HELI-COIL CORPORATION . . . DANBURY, CONN.
HELMS BAKERIES . . . . . LOS ANGELES, CALIF.
HELTZEL STEEL FORM & IRON COMPANY WARREN, OHIO

Honor Roll of Industrial Preparedness

HENDEY MACHINE COMPANY . . TORRINGTON, CONN.
HENDRICK MANUFACTURING COMPANY CARBONDALE, PA.
HENRY & WRIGHT DIV., EMHART MANUFACTURING COMPANY . . . . . HARTFORD, CONN.
HEPPENSTALL COMPANY . . . . . PITTSBURGH, PA.
HERCULES MOTORS CORPORATION. . CANTON, OHIO
HERCULES POWDER COMPANY . WILMINGTON, DEL.
HERKIMER TOOL AND MODEL WORKS, INC. . . . . HERKIMER, N.Y.
HERRON-ZIMMERS MOULDING COMPANY DETROIT, MICH.
HESSE-EASTERN CORPORATION . CAMBRIDGE, MASS.
HEYDEN CHEMICAL CORPORATION . NEW YORK, N.Y.
HEYL & PATTERSON, INC. . . . . PITTSBURGH, PA.
HEYWOOD WAKEFIELD COMPANY . . GARDNER, MASS.
HICKS & SON COMPANY, S. D. . . . BOSTON, MASS.
HIGGINS, INC. . . . . NEW ORLEANS, LA.
HIGH SPEED HAMMER COMPANY . . ROCHESTER. N.Y.
HIGH STANDARD MANUFACTURING CORPORATION . . . . . HAMDEN, CONN.
HIGHWAY TRAILER COMPANY . . . EDGERTON, WIS.
HILLER HELICOPTERS . . . . PALO ALTO, CALIF.
HOBART BROTHERS COMPANY . . . . TROY, OHIO
HOBART MANUFACTURING COMPANY . . TROY, OHIO
HOE & CO., INC., R. . . . . NEW YORK, N.Y.
HOFMANN & COMPANY, ALFRED WEST NEW YORK, N.J.
HOLLAND HITCH COMPANY . . . HOLLAND, MICH.
HOLLINGSHEAD CORPORATION, R. M. . . CAMDEN, N.J.
HOMAN & COMPANY . . . . CINCINNATI, OHIO
HOOSIER TARPAULIN & CANVAS GOODS COMPANY . . . . . INDIANAPOLIS, IND.
HOOVER COMPANY . . . . NORTH CANTON, OHIO
HORROCKS-IBBOTSON COMPANY . . . UTICA, N.Y.
HOTPOINT COMPANY, DIVISION OF GENERAL ELECTRIC COMPANY . . . . . CHICAGO, ILL.
HOUDAILLE-HERSHEY CORPORATION . DETROIT, MICH.
HOUGH COMPANY, FRANK G. . . LIBERTYVILLE, ILL.
HOUGHTON & COMPANY, E. F. . PHILADELPHIA, PA.
HOWELL COMPANY . . . . . ST. CHARLES, ILL.
HUBENY BROTHERS, INC. . . . . ROSELLE, N.J.
HUDSON COMPANY, J. L. . . . . DETROIT, MICH.
HUDSON MOTOR CAR COMPANY . . DETROIT, MICH.
HUGHES AIRCRAFT COMPANY DIVISION, HUGHES TOOL COMPANY . . . . . CULVER CITY, CALIF.
HUGHES-KEENAN CORPORATION . . DELAWARE, OHIO
HUGHES TOOL COMPANY . . . . HOUSTON, TEX.
HUNTER DOUGLAS CORPORATION . RIVERSIDE, CALIF.
HUNTER FAN & VENTILATING COMPANY . . . . . MEMPHIS, TENN.
HUNTER SPRING COMPANY . . . LANSDALE, PA.
HUPP CORPORATION . . . . CLEVELAND, OHIO
HUSSEY & COMPANY, C. G., DIVISION OF COPPER RANGE COMPANY . . . PITTSBURGH, PA.
HUSSMANN REFRIGERATOR COMPANY ST. LOUIS, MO.
HYATT BEARINGS DIVISION, GMC . . HARRISON, N.J.
HYDRAULIC PRESS MANUFACTURING COMPANY . . . . . MOUNT GILEAD, OHIO
HYDROPRESS, INC. . . . . NEW YORK, N.Y.

IDEAL ROLLER & MANUFACTURING COMPANY . . . . . CHICAGO, ILL.
ILLINOIS GEAR & MACHINE COMPANY CHICAGO, ILL.
ILLINOIS WATCH CASE COMPANY . . . ELGIN, ILL.
INDEPENDENT LOCK COMPANY . FITCHBURG, MASS.
INDIANA GEAR WORKS, INC. . . INDIANAPOLIS, IND.
INDUSTRIAL FILTER & PUMP MANUFACTURING COMPANY . . . . . CHICAGO, ILL.
INDUSTRIAL GEAR MANUFACTURING COMPANY . . . . . CHICAGO, ILL.
INDUSTRIAL STAMPING & MFG. CO. . DETROIT, MICH.
INDUSTRIAL WIRE CLOTH PRODUCTS CORPORATION . . . . . WAYNE, MICH.
INGALLS IRON WORKS COMPANY BIRMINGHAM, ALA.
INGRAHAM COMPANY, E. . . . . BRISTOL, CONN.
INLAND MANUFACTURING DIV., GMC . CHICAGO, ILL.
INLAND STEEL COMPANY . . . . CHICAGO, ILL.
INLAND STEEL PRODUCTS COMPANY MILWAUKEE, WIS.
INMAN MANUFACTURING COMPANY . AMSTERDAM, N.Y.
INTERCHEMICAL CORPORATION . . NEW YORK, N.Y.
INTER-COASTAL PAINT CORP. . . EAST ST. LOUIS, ILL.
INTERNATIONAL BUSINESS MACHINES CORPORATION . . . . . NEW YORK, N.Y.
INTERNATIONAL HARVESTER COMPANY CHICAGO, ILL.
INTERNATIONAL NICKEL COMPANY HUNTINGTON, W.VA.
INTERNATIONAL SILVER COMPANY . MERIDEN, CONN.
INTERNATIONAL SPARE PARTS DIVISION, QUEENSBORO PACKAGING CORPORATION . . . . LONG ISLAND CITY, N. Y.
IONIA MANUFACTURING COMPANY . . IONIA, MICH.
IRWIN AUGER BIT COMPANY . . WILMINGTON, OHIO
ITHACA GUN COMPANY . . . . . ITHACA, N.Y.

JACKES-EVANS MANUFACTURING COMPANY . . . . . ST. LOUIS, MO.
JACKSON AND CHURCH COMPANY . . SAGINAW, MICH.
JACOBS COMPANY, F. L. . . . . DETROIT, MICH.
JAHN TRAILER DIVISION, PRESSED STEEL CAR COMPANY . . . . . CHICAGO, ILL.
JANNEY CYLINDER COMPANY . . PHILADELPHIA, PA.
JARVIS ENGINEERING WORKS . . . LANSING, MICH.
JERNBERG FORGINGS COMPANY . . CHICAGO, ILL.
JESSOP STEEL COMPANY . . . WASHINGTON, PA.
JOHNS-MANVILLE SALES CORPORATION NEW YORK, N.Y.
JOHNSON SERVICE COMPANY . . MILWAUKEE, WIS.
JONES & LAMSON MACHINE COMPANY SPRINGFIELD, VT.
JONES & LAUGHLIN STEEL CORPORATION . . . . . PITTSBURGH, PA.
JOY MANUFACTURING COMPANY . PITTSBURGH, PA.

KABLE BROTHERS COMPANY . . MOUNT MORRIS, ILL.
KAHN ASSOCIATED ARCHITECTS & ENGINEERS, INC., ALBERT . . . . . DETROIT, MICH.
KAISER COMPANY, HENRY J. . . . OAKLAND, CALIF.
KAISER STEEL CORPORATION . . . OAKLAND, CALIF.
KAY MANUFACTURING CORPORATION BROOKLYN, N.Y.
KAYDON ENGINEERING CORPORATION . . . . . MUSKEGON, MICH.
KEARFOTT COMPANY . . . . LITTLE FALLS, N. J.
KEARNEY & TRECKER CORPORATION WEST ALLIS, WIS.
KELLOGG COMPANY, M. W. . . . NEW YORK, N.Y.
KELLY-SPRINGFIELD TIRE COMPANY CUMBERLAND, MD.
KELSEY-HAYES WHEEL COMPANY . . DETROIT, MICH.
KENNAMETAL, INC. . . . . LATROBE, PA.
KENNEDY-VAN SAUN MANUFACTURING & ENGINEERING COMPANY . . . DANVILLE, PA.

Honor Roll of Industrial Preparedness

KENT-MOORE ORGANIZATION, INC. . DETROIT, MICH.
KENWORTH MOTOR TRUCK CORP. . . SEATTLE, WASH.
KEUFFEL & ESSER COMPANY . . . HOBOKEN, N.J.
KEYSTONE MANUFACTURING COMPANY . . . . . BOSTON, MASS.
KIDDE & COMPANY, WALTER . . . BELLEVILLE, N.J.
KILGORE, INC. . . . . WESTERVILLE, OHIO
KING POWDER COMPANY . . . CINCINNATI, OHIO
KING-SEELEY CORPORATION . . ANN ARBOR, MICH.
KLEM CHEMICALS, INC. . . . DEARBORN, MICH.
KNAPP-MONARCH COMPANY . . . ST. LOUIS, MO.
KNOX METAL PRODUCTS, INC. . . THOMSON, GA.
KOEHRING COMPANY . . . . MILWAUKEE, WIS.
KOHLER COMPANY . . . . . KOHLER, WIS.
KOPPERS COMPANY . . . . . PITTSBURGH, PA.
KOVEN & BROTHER, INC., L. O. . JERSEY CITY, N.J.
KWIKSET LOCKS, INC. . . . . ANAHEIM, CALIF.
KYSOR HEATER COMPANY . . . . CADILLAC, MICH.

LACLEDE STEEL COMPANY . . . . ST. LOUIS, MO.
LAHER SPRING & TIRE CORPORATION OAKLAND, CALIF.
LAKE CITY MALLEABLE IRON CO. . CLEVELAND, OHIO
LAMSON CORPORATION . . . . SYRACUSE, N.Y.
LANDERS FRARY & CLARK . NEW BRITAIN, CONN.
LANDIS MACHINE COMPANY . . . ST. LOUIS, MO.
LANOVA CORPORATION . . LONG ISLAND CITY, N.Y.
LANSDOWNE STEEL & IRON COMPANY . MORTON, PA.
LANSING DROP FORGE COMPANY . . LANSING, MICH.
LAPOINTE MACHINE TOOL COMPANY . HUDSON, MASS.
LEAKE STAMPING COMPANY . . . MONROE, MICH.
LEBANON STEEL FOUNDRY . . . LEBANON, PA.
LE BUS ROTARY TOOL WORKS, INC. . LONGVIEW, TEX.
LEE MOTORS, INC. . . . . TOLEDO, OHIO
LEE TIRE & RUBBER COMPANY OF NEW YORK, INC. . . . CONSHOHOCKEN, PA.
LEECE-NEVILLE COMPANY . . . .CLEVELAND, OHIO
LEEDS & NORTHRUP COMPANY . PHILADELPHIA, PA.
LEES-BRADNER COMPANY . . . .CLEVELAND, OHIO
LEHIGH FOUNDRIES, INC. . . . . EASTON, PA.
LEHN & FINK PRODUCTS CORPORATION NEW YORK, N.Y.
LELAND ELECTRIC COMPANY . . . .DAYTON, OHIO
LEMPCO PRODUCTS, INC. . . . . BEDFORD, OHIO
LENNOX FURNACE COMPANY . . COLUMBUS, OHIO
LEWIS MANUFACTURING COMPANY . BAY CITY, MICH.
LIBBEY-OWENS-FORD GLASS COMPANY TOLEDO, OHIO
LIEBERKNECHT, INC., KARL . . . . READING, PA.
LIGGETT SUPPLY & EQUIPMENT COMPANY, INC. . . . . ELKHART, IND.
LIGON BROTHERS . . . . . DETROIT, MICH.
LINCOLN BRASS WORKS, INC. . . . DETROIT, MICH.
LINCOLN ELECTRIC COMPANY . . CLEVELAND, OHIO
LINCOLN ENGINEERING COMPANY . ST. LOUIS, MO.
LINK-BELT COMPANY . . . . . CHICAGO, ILL.
LION MANUFACTURING CORPORATION . CHICAGO, ILL.
LIPE-ROLLWAY CORPORATION . . SYRACUSE, N.Y.
LITTLE, INC., ARTHUR D. . . . CAMBRIDGE, MASS.
LOCKHEED AIRCRAFT CORPORATION . BURBANK, CALIF.
LOFTUS ENGINEERING CORPORATION . PITTSBURGH, PA.
LORRILLARD COMPANY, P. . . . NEW YORK, N.Y.
LOUISIANA POWER & LIGHT CO. . NEW ORLEANS, LA.
LUKENS STEEL COMPANY . . . COATESVILLE, PA.
LUMMUS COMPANY . . . . . NEW YORK, N.Y.
LUX CLOCK MANUFACTURING CO. . WATERBURY, CONN.
LYCOMING-SPENCER DIVISION, AVCO MANUFACTURING CORPORATION WILLIAMSPORT, PA.
LYNCHBURG FOUNDRY COMPANY . . LYNCHBURG, VA.
LYON, INCORPORATED . . . . . DETROIT, MICH.

MACK MANUFACTURING CORPORATION NEW YORK, N.Y.
MACKINTOSH-HEMPHILL COMPANY . PITTSBURGH, PA.
MAGIC CHEF, INC. . . . . ST. LOUIS, MO.
MAGNAFLUX CORPORATION . . . CHICAGO, ILL.
MAGNETIC METALS COMPANY . . . . CAMDEN, N.J.
MAHON COMPANY, R. C. . . . . DETROIT, MICH.
MAJESTIC MANUFACTURING COMPANY ST. LOUIS, MO.
MALL TOOL COMPANY . . . . . CHICAGO, ILL.
MANSFIELD TIRE & RUBBER COMPANY MANSFIELD, OHIO
MANUFACTURERS NATIONAL BANK OF DETROIT . . . . . DETROIT, MICH.
MARDIGIAN CORPORATION . . . DETROIT, MICH.
MARKEM MACHINE COMPANY . . . . KEENE, N.H.
MARLBORO WIRE GOODS COMPANY . MARLBORO, MASS.
MARLEY COMPANY, INC. . . . KANSAS CITY, MO.
MARLIN FIREARMS COMPANY . . NEW HAVEN, CONN.
MARLIN-ROCKWELL CORPORATION JAMESTOWN, N.Y.
MARMON-HERRINGTON COMPANY . INDIANAPOLIS, IND.
MARS SIGNAL LIGHT COMPANY . . CHICAGO, ILL.
MARTIN COMPANY, GLENN L. . . . BALTIMORE, MD.
MARTIN IRON WORKS . . . . . RENO, NEV.
MARTIN-PARRY CORPORATION . WASHINGTON, D.C.
MASCO SCREW PRODUCTS COMPANY . DEARBORN, MICH.
MASLAND & SONS, C. H. . . . . CARLISLE, PA.
MASON & HANGER COMPANY . . . NEW YORK, N.Y.
MASON COMPANY, L. E. . . . .HYDE PARK, MASS.
MASSEY-HARRIS COMPANY . . . . RACINE, WIS.
MASSMAN CONSTRUCTION CO. . . KANSAS CITY, MO.
MASTER BUILDERS COMPANY . . CLEVELAND, OHIO
MATHEWS CONVEYOR COMPANY . ELLWOOD CITY, PA.
MATHESON CHEMICAL CORPORATION . BALTIMORE, MD.
MAXSON CORPORATION, W. L. . . NEW YORK, N.Y.
MAYTAG COMPANY . . . . . NEWTON, IOWA
MCCARTHY-ROOT, INC. . . . . DETROIT, MICH.
MCCONWAY & TORLEY CORPORATION PITTSBURGH, PA.
MCCORD CORPORATION . . . . DETROIT, MICH.
MCDOWELL MANUFACTURING CO. . . PITTSBURGH, PA.
MCGLYNN HAYS INDUSTRIES, INC.. . BELLEVILLE, N. J.
MCGRAW ELECTRIC COMPANY . . . CHICAGO, ILL.
MCINERNEY SPRING & WIRE CO. GRAND RAPIDS, MICH.
MCKAY COMPANY . . . . . PITTSBURGH, PA.
MCKIERNAN-TERRY CORPORATION . HARRISON, N.J.
MCKINNEY & SON, INC., JAMES . . ALBANY, N.Y.
MCLOUTH STEEL CORPORATION . . DETROIT, MICH.
MCQUAY-NORRIS MANUFACTURING COMPANY . . . . . ST. LOUIS, MO.
MECHANICAL HANDLING SYSTEMS, INC. DETROIT, MICH.
MEDART COMPANY . . . . . .ST. LOUIS, MO.
MEDINA IRON AND BRASS CORPORATION MEDINA, N.Y.
MELCHOIR, ARMSTRONG, DESSAU COMPANY OF DELAWARE, INC. . . . . RIDGEFIELD, N.J.
MELLING FORGING COMPANY . . . LANSING, MICH.
MERCER TUBE & MANUFACTURING CO. . SHARON, PA.
MERGANTHALER LINOTYPE COMPANY . NEW YORK, N.Y.
MERZ ENGINEERING, INC. . . . INDIANAPOLIS, IND.
MESTA MACHINE COMPANY . . . PITTSBURGH, PA.

Honor Roll of Industrial Preparedness

METAL AUTO PARTS COMPANY . INDIANAPOLIS, IND.
METAL PRODUCTS CORPORATION . . . MIAMI, FLA.
METAL SCREEN CORPORATION . . . . MIAMI, FLA.
METAL SPECIALTY COMPANY . . CINCINNATI, OHIO
METALS DISINTEGRATING COMPANY . ELIZABETH, N.J.
METRO TOOL & DIE COMPANY . . . DETROIT, MICH.
METROPOLITAN BODY COMPANY . BRIDGEPORT, CONN.
MEYER MANUFACTURING COMPANY, GEO. J. . . . . CUDAHY, WIS.
MICA INSULATOR COMPANY . . . NEW YORK, N.Y.
MICHIGAN CONSOLIDATED GAS COMPANY DETROIT, MICH.
MICHIGAN STEEL CASTING COMPANY . DETROIT, MICH.
MICROMATIC HONE CORPORATION . DETROIT, MICH.
MIDVALE COMPANY . . . . PHILADELPHIA, PA.
MID-WEST ABRASIVE COMPANY . . OWOSSO, MICH.
MID-WEST HYDRO-PIERCE, INC. . . DETROIT, MICH.
MIDWEST PIPING AND SUPPLY COMPANY ST. LOUIS, MO.
MILCO UNDERGARMENT COMPANY . BLOOMSBURG, PA.
MILLER COMPANY . . . . . MERIDEN, CONN.
MILLER MANUFACTURING COMPANY . DETROIT, MICH.
MILLER MANUFACTURING COMPANY . RICHMOND, VA.
MILLER PRINTING MACHINERY COMPANY . . . . . PITTSBURGH, PA.
MILSCO MANUFACTURING COMPANY MILWAUKEE, WIS.
MILWAUKEE STAMPING COMPANY MILWAUKEE, WIS.
MINNEAPOLIS & ST. LOUIS RAILWAY COMPANY . . . . . MINNEAPOLIS, MINN.
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY . . . . . MINNEAPOLIS, MINN.
MINNEAPOLIS-MOLINE COMPANY MINNEAPOLIS, MINN.
MISSISSIPPI RIVER FUEL CORPORATION ST. LOUIS, MO.
MISSISSIPPI VALLEY BARGE LINE COMPANY . . . . . ST. LOUIS, MO.
MODINE MANUFACTURING COMPANY . . RACINE, WIS.
MOE LIGHT, INC. . . . . FORT ATKINSON, WIS.
MONARCH ALUMINUM MFG. COMPANY CLEVELAND, OHIO
MONARCH MARKING SYSTEM COMPANY DAYTON, OHIO
MONARCH RUBBER COMPANY . . . HARTVILLE, OHIO
MONROE AUTO EQUIPMENT COMPANY MONROE, MICH.
MONROE CALCULATING MACHINE COMPANY ORANGE, N.J.
MONTPELIER MANUFACTURING CO. MONTPELIER, OHIO
MOORE DROP FORGING COMPANY . SPRINGFIELD, MASS.
MOORE ENAMELING & MANUFACTURING COMPANY . . . . . W. LAFAYETTE, OHIO
MOORLANE COMPANY . . . . . TULSA, OKLA.
MOREY MACHINERY COMPANY . . ASTORIA, N.Y.
MORRISON STEEL PRODUCTS, INC. . BUFFALO, N.Y.
MORSE-SMITH-MORSE, INC. . . WATERTOWN, MASS.
MOSLER LOCK COMPANY . . . . COVINGTON, KY.
MOSLER SAFE COMPANY . . . . HAMILTON, OHIO
MOTOR PRODUCTS CORPORATION . . DETROIT, MICH.
MOTOR WHEEL CORPORATION . . . LANSING, MICH.
MOTOROLA, INC. . . . . CHICAGO, ILL.
MOTTER'S SONS, GEO. F. . . . . YORK, PA.
M-R-S MANUFACTURING COMPANY . . FLORA, MISS.
MUELLER BRASS COMPANY . . PORT HURON, MICH.
MUELLER FURNACE COMPANY, L. J. MILWAUKEE, WIS.
MULLINS MANUFACTURING CORPORATION SALEM, OHIO
MUNCIE GEAR WORKS, INC. . . . MUNCIE, IND.
MURRAY MANUFACTURING COMPANY, D. J. WAUSAU, WIS.
MURRAY MANUFACTURING CORPORATION NEW YORK, N.Y.
MURRAY OHIO MANUFACTURING CO. CLEVELAND, OHIO
NAGEL-CHASE MANUFACTURING COMPANY CHICAGO, ILL.
NARROW FABRIC COMPANY . . . . READING, PA.
NASH ENGINEERING COMPANY . . . . SOUTH NORWALK, CONN.
NASH-KELVINATOR CORPORATION . DETROIT, MICH.
NATIONAL ACME COMPANY . . CLEVELAND, OHIO
NATIONAL AUTOMOTIVE FIBERS, INC. DETROIT, MICH.
NATIONAL BANK OF DETROIT . . . DETROIT, MICH.
NATIONAL BRASS COMPANY . GRAND RAPIDS, MICH.
NATIONAL BROACH & MACHINE COMPANY . . . . . DETROIT, MICH.
NATIONAL CAN CORPORATION . . NEW YORK, N.Y.
NATIONAL CASH REGISTER COMPANY . DAYTON, OHIO
NATIONAL ELECTRIC PRODUCTS CORPORATION . . . . . PITTSBURGH, PA.
NATIONAL FIREWORKS ORDNANCE CORPORATION . . . . WEST HANOVER, MASS.
NATIONAL FOREMEN'S INSTITUTE, INC. . . . . NEW LONDON, CONN.
NATIONAL GYPSUM COMPANY . . . BUFFALO, N.Y.
NATIONAL LEAD COMPANY . . . NEW YORK, N.Y.
NATIONAL MACHINE PRODUCTS CO. . DETROIT, MICH.
NATIONAL MACHINERY COMPANY . . . TIFFIN, OHIO
NATIONAL MALLEABLE & STEEL CASTINGS COMPANY . . . . . CLEVELAND, OHIO
NATIONAL PNEUMATIC COMPANY . . BOSTON, MASS.
NATIONAL POWDER COMPANY . . . ELDRED, PA.
NATIONAL PRESSURE COOKER CO. . EAU CLAIRE, WIS.
NATIONAL RADIATOR COMPANY . JOHNSTOWN, PA.
NATIONAL REJECTORS, INC. . . . ST. LOUIS, MO.
NATIONAL RESEARCH CORPORATION CAMBRIDGE, MASS.
NATIONAL ROLL & FOUNDRY COMPANY AVONMORE, PA.
NATIONAL SCREW & MANUFACTURING COMPANY . . . . . CLEVELAND, OHIO
NATIONAL STAMPING COMPANY . . DETROIT, MICH.
NATIONAL SUPPLY COMPANY . . . PITTSBURGH, PA.
NATIONAL TOOL SALVAGE COMPANY . DETROIT, MICH.
NATIONAL TUBE COMPANY . . . PITTSBURGH, PA.
NATIONAL VENDORS, INC. . . . . ST. LOUIS, MO.
NEAPCO PRODUCTS, INC. . . . . POTTSTOWN, PA.
NESBITT, INC., JOHN J. . . . PHILADELPHIA, PA.
NESCO, INC. . . . . MILWAUKEE, WIS.
NEVILLE COMPANY . . . . . PITTSBURGH, PA.
NEW BRITAIN MACHINE COMPANY NEW BRITAIN, CONN.
NEW DEPARTURE DIVISION, GMC . . BRISTOL, CONN.
NEW ENGLAND BRASS COMPANY . . TAUNTON, MASS.
NEW ENGLAND PRESSED STEEL COMPANY NATICK, MASS.
NEW HAMPSHIRE BALL BEARINGS, INC. . . . . PETERBOROUGH, N. H.
NEW HAVEN CLOCK AND WATCH COMPANY . . . . . NEW HAVEN, CONN.
NEW ORLEANS PUBLIC SERVICE, INC. NEW ORLEANS, LA.
NEW PROCESS GEAR CORPORATION . SYRACUSE, N.Y.
NEW YORK AIR BRAKE COMPANY . NEW YORK, N.Y.
NEWARK STOVE COMPANY . . . NEWARK, OHIO
NEWMAN MACHINE COMPANY . . GREENSBORO, N.C.
NEWTON-NEW HAVEN COMPANY . WEST HAVEN, CONN.
NIAGARA BLOWER COMPANY . . . NEW YORK, N.Y.
NOBLE & COMPANY, F. H. . . . . CHICAGO, ILL.
NOMA ELECTRIC CORPORATION . . NEW YORK, N.Y.
NORDBERG MANUFACTURING CO. . MILWAUKEE, WIS.
NORQUIST PRODUCTS, INC. . . JAMESTOWN, N.Y.

Honor Roll of Industrial Preparedness

NORRIS, MANUFACTURER, INC., W. C. . TULSA, OKLA.
NORRIS-THERMADOR CORPORATION LOS ANGELES, CALIF.
NORTHFIELD FOUNDRY & MACHINE COMPANY . . . . . NORTHFIELD, MINN.
NORTHROP AIRCRAFT, INC., ANAHEIM DIV. . . . . ANAHEIM, CALIF.
NORTHWEST AUTOMATIC PRODUCTS CORPORATION . . . . MINNEAPOLIS, MINN.
NORTON COMPANY . . . . . WORCESTER, MASS.

O & S BEARING COMPANY . . . . DETROIT, MICH.
OAKITE PRODUCTS, INC. . . . . NEW YORK, N.Y.
OHIO RUBBER COMPANY . . . WILLOUGHBY, OHIO
OHIO STEEL FOUNDRY COMPANY . . . LIMA, OHIO
OILGEAR COMPANY . . . . MILWAUKEE, WIS.
OILJAK MANUFACTURING COMPANY .MONTCLAIR, N. J.
O'KEEFE & MERRITT COMPANY LOS ANGELES, CALIF.
OLDSMOBILE DIVISION, GMC . . . LANSING, MICH.
OLIN INDUSTRIES, INC. . . . . EAST ALTON, ILL.
OLIVER CORPORATION . . . . . CHICAGO, ILL.
OLIVER IRON AND STEEL CORPORATION PITTSBURGH, PA.
OLOFSSON TOOL & DIE COMPANY . . LANSING, MICH.
OLSEN MANUFACTURING COMPANY, SAMUEL . . . . . .CHICAGO, ILL.
ONEIDA LTD. . . . . ONEIDA, N. Y.
ONONDAGA POTTERY COMPANY . . SYRACUSE, N.Y.
ORLEANS MATERIALS & EQUIPMENT COMPANY . . . . . NEW ORLEANS, LA.
OSTER MANUFACTURING COMPANY CLEVELAND, OHIO
OTIS ELEVATOR COMPANY . . . . NEW YORK, N.Y.
OWENS-CORNING FIBERGLAS CORPORATION . . . . . WASHINGTON, D.C.
OWENS-ILLINOIS GLASS COMPANY . TOLEDO, OHIO

PACIFIC CAR AND FOUNDRY COMPANY RENTON, WASH.
PACKARD MOTOR CAR COMPANY . . DETROIT, MICH.
PANTEX MANUFACTURING CORPORATION . . . . . PAWTUCKET, R.I.
PARISH PRESSED STEEL COMPANY . . READING, PA.
PARKE THOMPSON ASSOCIATES . . KIRKWOOD, MO.
PARKER PEN COMPANY . . . JANESVILLE, WIS.
PARKER RUST PROOF COMPANY . . DETROIT, MICH.
PASS & SEYMOUR, INC. . . . . SYRACUSE, N.Y.
PATTON MANUFACTURING COMPANY SPRINGFIELD, OHIO
PECO PLANT, JOHN BEAN DIVISION, FOOD MACHINERY AND CHEMICAL CORPORATION . . . . . PHILADELPHIA, PA.
PEERLESS OF AMERICA, INC. . . . .CHICAGO, ILL.
PEMCO CORPORATION . . . . . BALTIMORE, MD.
PENBERTHY INJECTOR COMPANY . . DETROIT, MICH.
PENNSYLVANIA OPTICAL COMPANY . . READING, PA.
PENNSYLVANIA SALT MANUFACTURING COMPANY . . . . . PHILADELPHIA, PA.
PENNSYLVANIA TRANSFORMER CO. CANONSBURG, PA.
PERFEX CORPORATION . . . MILWAUKEE, WIS.
PERMUTIT COMPANY . . . . . NEW YORK, N.Y.
PFIZER & COMPANY, CHARLES . . NEW YORK, N.Y.
PHELPS DODGE COPPER PRODUCTS CORPORATION . . . . . NEW YORK, N.Y.
PHEOLL MANUFACTURING COMPANY . CHICAGO, ILL.
PHILADELPHIA BRONZE & BRASS CORPORATION . . . . . PHILADELPHIA, PA.
PHILCO CORPORATION . . . . PHILADELPHIA, PA.
PHOENIX BRIDGE COMPANY . . PHOENIXVILLE, PA.
PICKANDS MATHER & COMPANY . CLEVELAND, OHIO
PIERCE GOVERNOR COMPANY, INC. . ANDERSON, IND.
PITNEY-BOWES, INC. . . . . STAMFORD, CONN.
PITTSBURGH CONSOLIDATION COAL COMPANY . . . . . PITTSBURGH, PA.
PITTSBURGH FORGINGS COMPANY . . CORAOPOLIS, PA.
PITTSBURGH PLATE GLASS COMPANY . PITTSBURGH, PA.
PITTSBURGH STEEL FOUNDRY CORPORATION . . . . . PITTSBURGH, PA.
PITTSBURGH TUBE COMPANY . . . PITTSBURGH, PA.
PLUME & ATWOOD MANUFACTURING COMPANY . . . . . WATERBURY, CONN.
PLYMOUTH MOTOR CORPORATION . DETROIT, MICH.
POLORON PRODUCTS, INC. . . NEW ROCHELLE, N. Y.
PONTIAC MOTOR DIVISION, GMC . . PONTIAC, MICH.
POOR & COMPANY . . . . . CHICAGO, ILL.
PORCELAIN METALS CORPORATION . LOUISVILLE, KY.
PORTER COMPANY, H. K. . . . . PITTSBURGH, PA.
PORTLAND FORGE & FOUNDRY COMPANY . . . . . PORTLAND, IND.
POTTER & BRUMFIELD MANUFACTURING COMPANY . . . . . PRINCETON, IND.
PRATT & WHITNEY DIVISION, NILES-BEMENT-POND COMPANY . WEST HARTFORD, CONN.
PRECISION CASTINGS COMPANY . . SYRACUSE, N.Y.
PRECISION SPRING CORPORATION . . DETROIT, MICH.
PREFERRED UTILITIES MANUFACTURING CORPORATION . . . . . NEW YORK, N.Y.
PRICE-PFISTER BRASS MANUFACTURING COMPANY . . . . . LOS ANGELES, CALIF.
PROCTER & GAMBLE COMPANY . CINCINNATI, OHIO
PROCTOR ELECTRIC COMPANY . . PHILADELPHIA, PA.
PULLMAN-STANDARD CAR MANUFACTURING COMPANY . . . . . CHICAGO, ILL.
PUROLATOR PRODUCTS, INC. . . . RAHWAY, N.J.
PYLE-NATIONAL COMPANY . . . CHICAGO, ILL.

QUEEN PRODUCTS COMPANY . . . LOUISVILLE, KY.

RANDALL COMPANY . . . . CINCINNATI, OHIO
RAY OIL BURNER COMPANY . SAN FRANCISCO, CALIF.
RAYTHEON MANUFACTURING COMPANY . . . . . WALTHAM, MASS.
RCA VICTOR DIVISION, RADIO CORPORATION OF AMERICA . . . . . CAMDEN, N.J.
READ STANDARD CORPORATION . . NEW YORK, N.Y.
READING BATTERIES, INC. . . . . READING, PA.
READING TUBE CORPORATION . LONG ISLAND CITY, N.Y.
READY-POWER COMPANY . . . . DETROIT, MICH.
RED ARROW ELECTRONICS CORP. . . BELLEVILLE, N.J.
REDMOND COMPANY . . . . . OWOSSO, MICH.
REEVES INSTRUMENT CORPORATION . NEW YORK, N.Y.
REGINA CORPORATION . . . . . RAHWAY, N.J.
REMINGTON ARMS COMPANY . . BRIDGEPORT, CONN.
REMINGTON RAND INC. . . . STAMFORD, CONN.
REO MOTORS, INC. . . . . LANSING, MICH.
REPUBLIC STEEL CORPORATION . CLEVELAND, OHIO
REVERE COPPER & BRASS, INC. . . NEW YORK, N.Y.
REYNOLDS METALS COMPANY . . . RICHMOND, VA.
REYNOLDS SPRING COMPANY . . . JACKSON, MICH.
RHEEM MANUFACTURING COMPANY . NEW YORK, N.Y.

Honor Roll of Industrial Preparedness

RHODES, INC., M. H. . . . . HARTFORD, CONN.
RICHARDS-WILCOX MANUFACTURING COMPANY . . . . . AURORA, ILL.
RICHFIELD OIL CORPORATION . . LOS ANGELES, CALIF.
RICHMOND ENGINEERING COMPANY . RICHMOND, VA.
RICHMOND SCREW ANCHOR COMPANY NEW YORK, N.Y.
RIEDER BROTHERS . . . . . PHILADELPHIA, PA.
RIFE, INC., HOWARD C. . . . . ST. LOUIS, MO.
RINSHED-MASON COMPANY . . . DETROIT, MICH.
RITEPOINT COMPANY . . . . . ST. LOUIS, MO.
RIVERSIDE FOUNDRY, INC. . . BETTENDORF, IOWA
RIVERSIDE METAL COMPANY . . . RIVERSIDE, N.J.
ROBBINS TIRE & RUBBER COMPANY . TUSCUMBIA, ALA.
ROBERTS BRASS MANUFACTURING COMPANY . . . . . MITCHELL, IND.
ROBERTSHAW-FULTON CONTROLS COMPANY . . . . . GREENSBURG, PA.
ROCHESTER PRODUCTS DIVISION, GMC ROCHESTER, N.Y.
ROCKLAND FIREWORKS COMPANY . BOSTON, MASS.
ROCKWELL MANUFACTURING COMPANY PITTSBURGH, PA.
ROCKWOOD SPRINKLER COMPANY WORCESTER, MASS.
RODGERS HYDRAULIC, INC. . MINNEAPOLIS, MINN.
ROHN & HAAS COMPANY . . . PHILADELPHIA, PA.
RONSON ART METAL WORKS, INC. . NEWARK, N.J.
ROPER CORPORATION, GEORGE D. . . ROCKFORD, ILL.
ROSS CARRIER COMPANY . . BENTON HARBOR, MICH.
ROSS ENGINEERING CORPORATION, J. O. NEW YORK, N.Y.
ROSS GEAR AND TOOL COMPANY . LAFAYETTE, IND.
ROSS-MEEHAN FOUNDRIES . CHATTANOOGA, TENN.
ROTARY ELECTRIC STEEL COMPANY . DETROIT, MICH.
ROY, INC., ROSS . . . . . DETROIT, MICH.
ROYAL TYPEWRITER COMPANY . HARTFORD, CONN.
RUDEL MACHINERY COMPANY . . . NEW YORK, N.Y.
RUDISILL FOUNDRY COMPANY . . ANNISTON, ALA.
RYERSON & HAYNES, INC. . . . . JACKSON, MICH.

S & M LAMP COMPANY . . LOS ANGELES, CALIF.
S & S CORRUGATED PAPER MACHINERY COMPANY . . . . . BROOKLYN, N.Y.
SACO-LOWELL SHOPS . . . . . BOSTON, MASS.
SAE STEELS . . . . . CLEVELAND, OHIO
SAFRAN PRINTING COMPANY . . . DETROIT, MICH.
SAGINAW MALLEABLE IRON DIVISION, GMC . . . . . SAGINAW, MICH.
SAGINAW STEERING GEAR DIVISION, GMC . . . . . SAGINAW, MICH.
ST. CLAIR RUBBER COMPANY . . . DETROIT, MICH.
ST. LOUIS CAR COMPANY . . . . ST. LOUIS, MO.
ST. REGIS PAPER COMPANY . . . NEW YORK, N.Y.
SALEM ENGINEERING DIV., SALEM-BROSIUS, INC. . . . . SALEM, OHIO
SALEM TOOL COMPANY . . . . . SALEM, OHIO
SAMPSEL TIME CONTROL, INC. . SPRING VALLEY, ILL.
SANDERSON & PORTER . . . . . NEW YORK, N.Y.
SANDIA CORPORATION . . .ALBUQUERQUE, N. MEX.
SANDPAPER, INC. . . . . ROCKLAND, MASS.
SARGENT & GREENLEAF, INC. . . . ROCHESTER, N.Y.
SAVAGE ARMS CORPORATION . . . . UTICA, N.Y.
SCAIFE COMPANY . . . . . PITTSBURGH, PA.
SCHABERG-DIETRICH HARDWARE CO. . LANSING, MICH.
SCHAIBLE COMPANY . . . . CINCINNATI, OHIO
SCHLAGE LOCK COMPANY . . SAN FRANCISCO, CALIF.
SCHLITZ BREWING COMPANY, JOSEPH MILWAUKEE, WIS.
SCHLUETER MANUFACTURING COMPANY ST. LOUIS, MO.
SCHWITZER-CUMMINS COMPANY . INDIANAPOLIS, IND.
SCOVILL MANUFACTURING COMPANY WATERBURY, CONN.
SCREW PRODUCTS CORPORATION OF AMERICA . . . . . SOUTH GATE, CALIF.
SCULLIN STEEL COMPANY . . . . ST. LOUIS, MO.
SEAMAN MOTORS, INC. . . . . MILWAUKEE, WIS.
SEAMLESS RUBBER COMPANY . . NEW HAVEN, CONN.
SEEGER REFRIGERATOR COMPANY . ST. PAUL, MINN.
SEIBERLING RUBBER COMPANY . . . AKRON, OHIO
SELMER, INC., H. & A., JESSE FRENCH & SONS PIANO DIVISION . . . NEW CASTLE, IND.
SERVEL, INC. . . . . EVANSVILLE, IND.
SESSIONS CLOCK COMPANY . . FORESTVILLE, CONN.
SEXTON CAN COMPANY . . . . EVERETT, MASS.
SHAFER BEARING CORPORATION DOWNERS GROVE, ILL.
SHAKEPROOF, INC., DIV., ILLINOIS TOOL WORKS . . . . . ELGIN, ILL.
SHARON STEEL CORPORATION . . . . SHARON, PA.
SHEAFFER PEN COMPANY, W. A. FORT MADISON, IOWA
SHEFFIELD CORPORATION . . . . DAYTON, OHIO
SHEFFIELD STEEL CORPORATION . KANSAS CITY, MO.
SHELL OIL COMPANY . . . . . NEW YORK, N.Y.
SHENANGO AGALOY TUBE COMPANY SPRINGFIELD, OHIO
SHERWIN-WILLIAMS COMPANY . CLEVELAND, OHIO
SHRIVER & COMPANY, T. . . . . HARRISON, N.J.
SILAS MASON COMPANY . . . SHREVEPORT, LA.
SILENT GLOW OIL BURNER CORP. . HARTFORD, CONN.
SIMMONS COMPANY . . . . . NEW YORK, N.Y.
SIMONDS SAW & STEEL COMPANY . FITCHBURG, MASS.
SIMPLEX TIME RECORDER COMPANY . GARDNER, MASS.
SINGER MANUFACTURING COMPANY ELIZABETHPORT, N.J.
SIVYER STEEL CASTING COMPANY MILWAUKEE, WIS.
SKF INDUSTRIES, INC. . . . . PHILADELPHIA, PA.
SLAYMAKER LOCK COMPANY . . . LANCASTER, PA.
SLOSS-SHEFFIELD STEEL & IRON CO. BIRMINGHAM, ALA.
SMITH & CORONA TYPEWRITERS, INC., L. C. . . . . SYRACUSE, N.Y.
SMITH & WESSON, INC. . . . SPRINGFIELD, MASS.
SMITH COMPANY, S. MORGAN . . . . YORK, PA.
SMITH COMPANY, T. L. . . . . MILWAUKEE, WIS.
SMITH CORPORATION, A. O. . . MILWAUKEE, WIS.
SMITH, DRUM & COMPANY . . PHILADELPHIA, PA.
SMITH, INC., ALEXANDER . . . . YONKERS, N.Y.
SNYDER MANUFACTURING COMPANY, H. P. . . . . LITTLE FALLS, N.Y.
SNYDER TOOL & ENGINEERING COMPANY DETROIT, MICH.
SOCONY-VACUUM OIL COMPANY . . DETROIT, MICH.
SORENG MANUFACTURING CORPORATION . . . . SCHILLER PARK, ILL.
SOUTH BEND LATHE WORKS . . SOUTH BEND, IND.
SOUTHERN COACH MANUFACTURING COMPANY . . . . . EVERGREEN, ALA.
SOUTHERN NATURAL GAS COMPANY BIRMINGHAM, ALA.
SOUTHERN STATES EQUIPMENT CORPORATION . . . . . .HAMPTON, GA.
SOUTHWEST STONE COMPANY . . . . DALLAS, TEX.
SPALDING & BROS., INC., A. G. . . CHICOPEE, MASS.
SPARKLER MANUFACTURING COMPANY MUNDELEIN, ILL.
SPEAKER CORPORATION, J. W. . MILWAUKEE, WIS.
SPECIALTIES, INC. . . . . SYOSSET, N.Y.

Honor Roll of Industrial Preparedness

SPEED-O-PRINT CORPORATION . . CHICAGO, ILL.
SPEED QUEEN CORPORATION . . . . RIPON, WIS.
SPENCER CHEMICAL COMPANY . KANSAS CITY, MO.
SPERRY CORPORATION . . . . . NEW YORK, N. Y.
SPERRY GYROSCOPE COMPANY . GREAT NECK, N.Y.
SPICER MANUFACTURING DIVISION, DANA CORPORATION . . . . TOLEDO, OHIO
SPRAGUE & CARLETON, INC. . . . . KEENE, N.H.
SPRAGUE ELECTRIC COMPANY . NORTH ADAMS, MASS.
SPROUT, WALDRON & COMPANY . . . MUNCY, PA.
SQUARE D COMPANY . . . . . DETROIT, MICH.
STAMPING PRODUCTS & MANUFACTURING COMPANY . . . . . DETROIT, MICH.
STANDARD ASBESTOS MFG. COMPANY . CHICAGO, ILL.
STANDARD CONTAINER, INC. . . . MONTCLAIR, N.J.
STANDARD FORGINGS CORPORATION . CHICAGO, ILL.
STANDARD GAGE COMPANY . . POUGHKEEPSIE, N.Y.
STANDARD PRODUCTS COMPANY . . DETROIT, MICH.
STANDARD RAILWAY EQUIPMENT MANUFACTURING COMPANY . . CHICAGO, ILL.
STANDARD SERVICE TIRE COMPANY, INC. . . . . SEATTLE, WASH.
STANDARD STEEL SPRING COMPANY . CORAOPOLIS, PA.
STANDARD TUBE COMPANY . . . DETROIT, MICH.
STARLINE INCORPORATED . . . . HARVARD, ILL.
STEARNS-ROGERS MANUFACTURING CO. DENVER, COLO.
STEEL CITY ELECTRIC COMPANY . . PITTSBURGH, PA.
STEEL IMPROVEMENT & FORGE CO. CLEVELAND, OHIO
STERLING ENGINE COMPANY . . . BUFFALO, N. Y.
STERLING ENGINEERING COMPANY . NEWARK, N.J.
STEVENS & COMPANY, J. P. . . . NEW YORK, N.Y.
STEWART-WARNER CORPORATION . CHICAGO, ILL.
STILE-CRAFT MANUFACTURERS, INC. . ST. LOUIS, MO.
STOCKHAM VALVES & FITTINGS . BIRMINGHAM, ALA.
STOKES MACHINE COMPANY, F. J. PHILADELPHIA, PA.
STOLLE CORPORATION . . . . . CINCINNATI, OHIO
STONE & WEBSTER ENGINEERING CORPORATION . . . . . NEW YORK, N.Y.
STONER MANUFACTURING CORPORATION AURORA, ILL.
STONER-MUDGE, INC. . . . . PITTSBURGH, PA.
STRELINGER COMPANY, CHAS. A. . . DETROIT, MICH.
STROMBERG TIME CORPORATION . . NEW YORK, N.Y.
STRONG STEEL FOUNDRY COMPANY . BUFFALO, N.Y.
STUART OIL COMPANY, D. A. . . . CHICAGO, ILL.
STUDEBAKER CORPORATION . . SOUTH BEND, IND.
SUN ELECTRIC CORPORATION . . . CHICAGO, ILL.
SUN OIL COMPANY . . . . . PHILADELPHIA, PA.
SUPERIOR COACH CORPORATION . . . LIMA, OHIO
SUPERIOR SHEET STEEL DIVISION, LOUIS BERKMAN COMPANY . . . CANTON, OHIO
SUPERIOR STEEL CORPORATION . . CARNEGIE, PA.
SUPREME KNITTING MACHINE COMPANY NEW YORK, N.Y.
SURFACE COMBUSTION CORPORATION TOLEDO, OHIO
SUTTON CORPORATION, O. A. . . . WICHITA, KANS.
SWAN-FINCH OIL CORPORATION . . NEW YORK, N.Y.
SWANK, INC. . . . . ATTLEBORO, MASS.
SWARD COMPANY, H. A. . . . . INWOOD, N.Y.
SYLVANIA ELECTRIC PRODUCTS, INC. . NEW YORK, N.Y.
SYMINGTON-GOULD CORPORATION . . DEPEW, N.Y.

TABER INSTRUMENT CORPORATION . . . NORTH TONAWANDA, N.Y.
TALON, INC. . . . . MEADVILLE, PA.
TAYLOR & GASKIN, INC. . . . . DETROIT, MICH.
TEINER COMPANY, ROLAND . . . EVERETT, MASS.
TEMCO, INC. . . . . NASHVILLE, TENN.
TENNANT, SONS & COMPANY OF NEW YORK, C. . . . . NEW YORK, N.Y.
TENNESSEE COAL & IRON DIVISION, U. S. STEEL COMPANY . . . . . FAIRFIELD, ALA.
TENNESSEE CORPORATION . . . . NEW YORK, N.Y.
TENNESSEE EASTMAN COMPANY . KINGSPORT, TENN.
TENNEY ENGINEERING, INC. . . . NEWARK, N.J.
TERNSTEDT DIVISION, GMC . . . DETROIT, MICH.
TERRELL MACHINE COMPANY . . CHARLOTTE, N.C.
TEXAS GULF SULPHUR COMPANY . . NEW YORK, N.Y.
TEXAS INSTRUMENTS INCORPORATED . DALLAS, TEX.
TEXTILE MACHINE WORKS . . . READING, PA.
TEXTILEATHER CORPORATION . . TOLEDO, OHIO
THIOKOL CORPORATION . . . . TRENTON, N.J.
THOMPSON PRODUCTS, INC. . . CLEVELAND, OHIO
THOR CORPORATION . . . . . CHICAGO, ILL.
TIMKEN-DETROIT AXLE COMPANY . DETROIT, MICH.
TIMKEN ROLLER BEARING COMPANY . CANTON, OHIO
TIMMS SPRING COMPANY . . . . ELYRIA, OHIO
TITAN METAL MANUFACTURING CO. . BELLEFONT, PA.
TITEFLEX, INC. . . . . NEWARK, N.J.
TOKHEIM OIL TANK AND PUMP CO. FORT WAYNE, IND.
TOWNSEND COMPANY . . . . NEW BRIGHTON, PA.
TRACTOMOTIVE CORPORATION . . DEERFIELD, ILL.
TRAILMOBILE, INC. . . . . CINCINNATI, OHIO
TRANSUE & WILLIAMS STEEL FORGING CORPORATION . . . . . ALLIANCE, OHIO
TREADWELL CONSTRUCTION COMPANY MIDLAND, PA.
TREDEGAR COMPANY . . . . . RICHMOND, VA.
TRI-CLOVER MACHINE COMPANY . . KENOSHA, WIS.
TRICO PRODUCTS CORPORATION . . BUFFALO, N.Y.
TRIFARI, KRUSSMAN & FISHEL, INC. . PROVIDENCE, R. I.
TRIPLEX CORPORATION OF AMERICA . PUEBLO, COLO.
TROJAN POWDER COMPANY . . . ALLENTOWN, PA.
TUBE REDUCING CORPORATION . WALLINGTON, N.J.
TULSA WINCH DIVISION, VICKERS, INC. TULSA, OKLA.
TURNER BRASS WORKS . . . . SYCAMORE, ILL.
TWIN DISC CLUTCH COMPANY . . . RACINE, WIS.
TYSON BEARING CORPORATION . MASSILLON, OHIO

UDYLITE CORPORATION . . . . DETROIT, MICH.
ULTRASONIC CORPORATION . . CAMBRIDGE, MASS.
UNDERWOOD CORPORATION . . . NEW YORK, N.Y.
UNION BAG & PAPER CORPORATION . NEW YORK, N.Y.
UNION CARBIDE AND CARBON CORP. . NEW YORK, N.Y.
UNION METAL MANUFACTURING COMPANY CANTON, OHIO
UNITED AIRCRAFT CORPORATION EAST HARTFORD, CONN.
UNITED-CARR FASTENER CORP. . CAMBRIDGE, MASS.
UNITED CHROMIUM, INC. . . . . NEW YORK, N.Y.
UNITED ENGINEERING & FOUNDRY CO. PITTSBURGH, PA.
UNITED MACHINE COMPANY . . FORT WORTH, TEX.
UNITED METAL BOX COMPANY . . NEW YORK, N.Y.
UNITED MOTORS SERVICE DIVISION, GMC DETROIT, MICH.
UNITED PLATERS, INC. . . . . DETROIT, MICH.
UNITED SHOE MACHINERY CORPORATION BOSTON, MASS.
UNITED SPECIALTIES COMPANY . . CHICAGO, ILL.
UNITED STATES AIR CONDITIONING CORPORATION . . . . MINNEAPOLIS, MINN.

Honor Roll of Industrial Preparedness

UNITED STATES HOFFMAN MACHINERY CORPORATION . . . . . NEW YORK, N.Y.
U. S. MACHINE CORPORATION . . . LEBANON, IND.
UNITED STATES PIPE AND FOUNDRY COMPANY . . . . . BURLINGTON, N.J.
UNITED STATES RADIATOR CORPORATION DETROIT, MICH.
UNITED STATES RUBBER COMPANY . NEW YORK, N.Y.
UNITED STATES SPRING AND BUMPER COMPANY . . . . . LOS ANGELES, CALIF.
UNITED STATES STEEL COMPANY . . PITTSBURGH, PA.
UNITED STATES STEEL SUPPLY COMPANY CHICAGO, ILL.
UNITED STATES TIME CORPORATION WATERBURY, CONN.
UNITED TRANSPORTS, INC. OKLAHOMA CITY, OKLA.
UNITED TUBE CORPORATION OF OHIO CLEVELAND, OHIO
UNIVERSAL BUTTON FASTENING AND BUTTON COMPANY . . . . . DETROIT, MICH.
UNIVERSAL MATCH CORPORATION . ST. LOUIS, MO.
UNIVERSAL OIL PRODUCTS COMPANY DES PLAINES, ILL.
UNIVERSAL PRODUCTS COMPANY . DEARBORN, MICH.
UNIVERSAL WINDING COMPANY . . CRANSTON, R.I.

VANDERCOOK & SONS, INC. . . . CHICAGO, ILL.
VAN DORN IRON WORKS COMPANY CLEVELAND, OHIO
VAN KEUREN COMPANY . . . WATERTOWN, MASS.
VAN NORMAN COMPANY . . . SPRINGFIELD, MASS.
VARD INC. . . . . PASADENA, CALIF.
VASCOLOY-RAMET CORPORATION . . WAUKEGAN, ILL.
VEEDER-ROOT, INC. . . . . HARTFORD, CONN.
VELSICOL CORPORATION . . . . CHICAGO, ILL.
VERSON ALLSTEEL PRESS COMPANY . CHICAGO, ILL.
VICKERS, INC. . . . . DETROIT, MICH.
VICTOR ADDING MACHINE COMPANY . CHICAGO, ILL.
VICTOR MANUFACTURING & GASKET COMPANY . . . . . CHICAGO, ILL.
VICTORY PLASTICS COMPANY . . . HUDSON, MASS.
VIKING TOOL & MACHINE CORPORATION BELLEVILLE, N.J.
VISKING CORPORATION . . . . CHICAGO, ILL.
VITRO CORPORATION OF AMERICA . NEW YORK, N.Y.
VOLCO BRASS AND COPPER COMPANY KENILWORTH, N.J.

WADE ELECTRIC PRODUCTS COMPANY STURGIS, MICH.
WAGNER ELECTRIC CORPORATION . ST. LOUIS, MO.
WAGNER MALLEABLE IRON COMPANY DECATUR, ILL.
WALDES KOHINOOR, INC. . . LONG ISLAND CITY, N.Y.
WALKER MANUFACTURING COMPANY OF WISCONSIN . . . . . RACINE, WIS.
WALL COLMONOY CORPORATION . . DETROIT, MICH.
WALTERS MANUFACTURING COMPANY OAKMONT, PA.
WALTHAM WATCH COMPANY . . . WALTHAM, MASS.
WALWORTH COMPANY . . . . . NEW YORK, N.Y.
WARD LAFRANCE TRUCK CORPORATION . ELMIRA, N.Y.
WARE BROTHERS DIVISION, CHICAGO ROLLER SKATE COMPANY . . . . . CHICAGO, ILL.
WARNER & SWASEY COMPANY . CLEVELAND, OHIO
WARNER ELECTRIC BRAKE & CLUTCH CO. BELOIT, WIS.
WARREN BROTHERS ROADS COMPANY CAMBRIDGE, MASS.
WARREN FOUNDRY & PIPE CORPORATION NEW YORK, N.Y.
WARREN WEBSTER & COMPANY . . . CAMDEN, N.J.
WATERBURY COMPANIES, INCORPORATED . . . . . WATERBURY, CONN.
WATERBURY FARREL FOUNDRY & MACHINE COMPANY . . . . . WATERBURY, CONN.
WATSON-STILLMAN COMPANY . . . ROSELLE, N. J.
WATTS REGULATOR COMPANY . . LAWRENCE, MASS.
WAUKESHA MOTOR COMPANY . . . WAUKESHA, WIS.
WEATHERHEAD COMPANY . . . CLEVELAND, OHIO
WEBB COMPANY, JERVIS B. . . . DETROIT, MICH.
WEIRTON STEEL COMPANY . . WEIRTON, W.VA.
WELLMAN COMPANY, S. K. . . . BEDFORD, OHIO
WERNER COMPANY, R. D. . . . . GREENVILLE, PA.
WEST BEND ALUMINUM COMPANY . WEST BEND, WIS.
WEST POINT MANUFACTURING COMPANY BOSTON, MASS.
WEST SIDE MACHINE WORKS, INC. KANSAS CITY, KANS.
WEST TIRE SETTER COMPANY . . . ROCHESTER, N.Y.
WESTERN ARC WELDING, INC. . . LOS ANGELES, CALIF.
WESTERN ELECTRIC COMPANY . . NEW YORK, N.Y.
WESTERN FELT WORKS . . . . CHICAGO, ILL.
WESTERN FOUNDRY COMPANY . . CHICAGO, ILL.
WESTERN GEAR WORKS . . . LYNWOOD, CALIF.
WESTINGHOUSE AIR BRAKE COMPANY WILMERDING, PA.
WESTINGHOUSE ELECTRIC CORPORATION . . . . . PITTSBURGH, PA.
WESTMORLAND METAL MANUFACTURING COMPANY . . . . . PHILADELPHIA, PA.
WHEEL TRUEING TOOL COMPANY . . DETROIT, MICH.
WHEELER CORPORATION, FOSTER . . NEW YORK, N.Y.
WHEELING STEEL CORPORATION . WHEELING, W.VA.
WHEELOCK, LOVEJOY & COMPANY CAMBRIDGE, MASS.
WHELAND COMPANY . . . CHATTANOOGA, TENN.
WHIRLPOOL CORPORATION . . ST. JOSEPH, MICH.
WHITE MOTOR COMPANY . . . CLEVELAND, OHIO
WHITE RODGERS ELECTRIC COMPANY . ST. LOUIS, MO.
WHITE SEWING MACHINE CORP. . CLEVELAND, OHIO
WHITEHEAD & KALES COMPANY . RIVER ROUGE, MICH.
WHITEHEAD STAMPING COMPANY . . DETROIT, MICH.
WHITIN MACHINE WORKS . . WHITINSVILLE, MASS.
WHITIN MANUFACTURING COMPANY, PAUL . . . . . NORTHBRIDGE, MASS.
WHITING & DAVIS COMPANY . . PLAINVILLE, MASS.
WICKES BROTHERS DIVISION, WICKES CORPORATION . . . . . SAGINAW, MICH.
WICO ELECTRIC COMPANY . WEST SPRINGFIELD, MASS.
WIEGAND COMPANY, EDWIN L. . . PITTSBURGH, PA.
WILCOX FORGING CORPORATION . MECHANICSBURG, PA.
WILLARD STORAGE BATTERY CO. . CLEVELAND, OHIO
WILLOUGHBY CHEVROLET COMPANY . RICHMOND, IND.
WILLYS-OVERLAND MOTORS, INC. . TOLEDO, OHIO
WILMINGTON CASTING COMPANY . WILMINGTON, OHIO
WINCHESTER REPEATING ARMS CO. NEW HAVEN, CONN.
WINTER-WEISS COMPANY . . . . DENVER, COLO.
WIPING MATERIALS, INC. . . . . ST. LOUIS, MO.
WIREMOLD COMPANY . . . . HARTFORD, CONN.
WISCONSIN MOTOR CORPORATION MILWAUKEE, WIS.
WOLFE, HARRY M. . . . . CHICAGO, ILL.
WOLVERINE FABRICATING & MANUFACTURING COMPANY . . . . . INKSTER, MICH.
WOLVERINE TUBE DIVISION, CALUMET & HECLA, INC. . . . DETROIT, MICH.
WOOD COMPANY, JOHN . . CONSHOHOCKEN, PA.
WOOD COMPANY, R. D. . . . PHILADELPHIA, PA.
WOOD-MOSAIC COMPANY . . . . LOUISVILLE, KY.
WORCESTER PRESSED STEEL COMPANY . . . . . WORCESTER, MASS.

Honor Roll of Industrial Preparedness

WORCESTER STAMPED METAL COMPANY . . . . . WORCESTER, MASS.
WORCESTER TAPER PIN COMPANY . . . WORCESTER, MASS.
WORDEN-ALLEN COMPANY . . . . MILWAUKEE, WIS.
WRIGHT MACHINE COMPANY . . . WORCESTER, MASS.
WROUGHT IRON RANGE COMPANY . . ST. LOUIS, MO.
WYANDOTTE CHEMICALS CORPORATION . . . . . WYANDOTTE, MICH.
WYANDOTTE PAINT PRODUCTS COMPANY . . . . . WYANDOTTE, MICH.
WYCKOFF STEEL COMPANY . . . . PITTSBURGH, PA.
WYSONG & MILES COMPANY . . . GREENSBORO, N.C.

YODER COMPANY . . . . . CLEVELAND, OHIO
YORK CORPORATION . . . . . YORK, PA.
YORK-SHIPLEY, INC. . . . . YORK, PA.
YOUNG RADIATOR COMPANY . . . . RACINE, WIS.
YOUNG SPRING & WIRE CORPORATION, L. A. . . . . DETROIT, MICH.
YOUNGSTOWN SHEET & TUBE COMPANY . . . . . YOUNGSTOWN, OHIO

ZENITE METAL CORPORATION . . INDIANAPOLIS, IND.
ZENITH RADIO CORPORATION . . . CHICAGO, ILL.
ZIM MANUFACTURING COMPANY . . CHICAGO, ILL.